Parker Landfill Project
Lyndonville, Vermont
Project No. 4905024

FEASIBILITY STUDY

VOLUME 1 OF 2
TEXT, FIGURES, & TABLES

Prepared on Behalf of:

THE PARKER LANDFILL TASK GROUP
LYNDONVILLE, VERMONT

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Submitted To:

U.S. EPA REGION 1
BOSTON, MASSACHUSETTS

DRAFT: JANUARY 18, 1994
FINAL: JUNE 1, 1994

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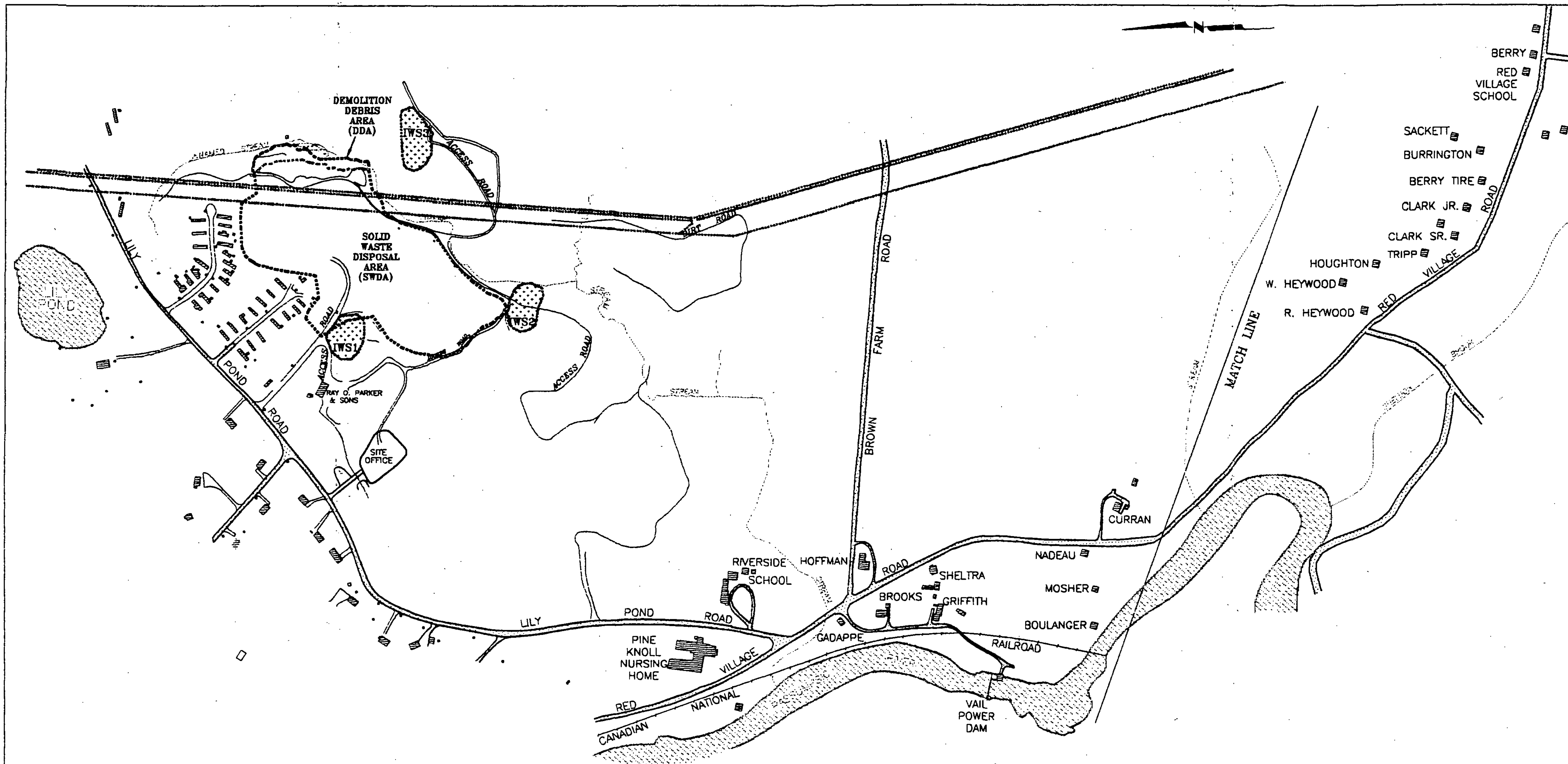
Executive Summary

EXECUTIVE SUMMARY

E.1 PURPOSE OF THE REPORT

These documents present the Remedial Investigation/Feasibility Study (RI/FS) which was completed for the Parker Landfill Project pursuant to the requirements of U.S. Environmental Protection Agency (EPA) Administrative Order by Consent, Docket Number I-90-1089 (Administrative Order), effective August 10, 1990. The Parker Landfill (Landfill) is located near the Village of Lyndonville, within the Town of Lyndon, Vermont. The Landfill is contained within approximately 25 acres of a 75 acre parcel on the southern side of Lily Pond Road, approximately 0.2 mile southeast of Lily Pond in the southeast portion of the Town of Lyndon, Caledonia County, Vermont. The Landfill (see Figure E-1) contains a solid waste disposal area (SWDA) and three smaller industrial waste areas (IWS Areas).

Investigation of the Landfill by the Vermont Department of Environmental Conservation (VTDEC) began in 1984 when routine sampling by the VTDEC revealed the presence of chlorinated volatile organic compounds (VOC) in monitoring wells in the vicinity of the SWDA and IWS Areas and in stream locations on the perimeter of the SWDA and IWS Areas. Follow-up sampling has detected VOC above Maximum Contaminant Levels (MCL) in five private wells south of the Landfill. During 1985, VTDEC completed a Preliminary Assessment and an Uncontrolled Hazardous Waste Site Evaluation. Based upon the results of those studies, EPA proposed the Landfill for listing on the National Priorities List on June 21, 1988. On February 16, 1990 the Landfill was listed on the National Priorities List. On August 10, 1990 the Respondents voluntarily entered into an Administrative Order with the EPA. This Administrative Order sets forth the requirements for the preparation and performance of a Remedial Investigation and Feasibility Study (RI/FS). The Remedial Investigation Report details the field studies performed and the data collected, to provide a comprehensive summary of the Phase 1A and Phase 1B Remedial Investigation (RI) activities, results, and data evaluations. Based on the conceptual model of study area conditions developed during the RI, the FS report



NOTES:

1. BASE MAP FROM "TOPOGRAPHIC WORKSHEET OF THE PARKER LANDFILL", DATED SEPTEMBER 5, 1987, PROVIDED BY EASTERN TOPOGRAPHICS, WOLFBORO, NEW HAMPSHIRE, TO A SCALE OF ONE INCH EQUALS 100 FEET.
2. SURVEY DATUM IS 1929 USGS MEAN SEA LEVEL.
3. PLAN AREA SOUTH OF MATCH LINE BASED ON USGS PROVISIONAL MAPS, BURKE MOUNTAIN AND LYNDONVILLE QUADRANGLES, 7.5 MINUTE SERIES, TO A SCALE OF 1:24000.
4. EXTENT OF IWS AND SWDA AREAS IS APPROXIMATE.

LEGEND

- SNOW FENCE (SURROUNDING IWS AREAS)
- LANDFILL LIMIT MONUMENT
- UTILITY POLE
- DIRT ROAD
- POWERLINES

0 500 1000
SCALE IN FEET

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PLAN OF PARKER LANDFILL AND SURROUNDING VICINITY

FIGURE E-1

DRAWING NAME: CULEXEC.DWG		FILE NUMBER: 4905024	
SCALE: 1"=500'	REVISION: 0	DRAWN BY: PLM	DATE: 11/12/92

presents the identification of response areas, and identification, development, and evaluation of remedial alternatives for the Landfill.

E.2 STUDY AREA DESCRIPTION

The Landfill is located in an area of open hilly terrain. The topography of the region is generally hilly to mountainous. Several hills within a few miles of the Landfill have a vertical relief of 200 to 300 feet. Abutting the 75 acre parcel are woodlands, pasture land, and developed land. An unnamed stream traverses the Study Area, joins with two larger unnamed streams immediately southeast of the Landfill, and flows south and southwest to the Passumpsic River.

To the north, approximately 0.3 mile from the Landfill are three mobile home communities and seven single family homes, and beyond Lily Pond is a combination of pasture land, crop land, and woodland. To the west of the Landfill, about 0.5 mile, is a combination of woodland and a residential development (approximately 40 homes). To the south is a combination of woodland, pasture land, and crop land. A private school, a nursing home, and five single family homes are located about 0.5 mile south of the Landfill. East of the Landfill are hilly woodlands.

E.3 SUMMARY OF REMEDIAL INVESTIGATION FIELD INVESTIGATIONS

The area investigated during the RI (Study Area) includes the Landfill, areas west to Lily Pond Road, and south, on both sides of Red Village Road to the point where Red Village Road turns east. In order to evaluate the geology and hydrogeology of the Study Area, geophysical investigations were conducted, 39 test borings were completed, 73 monitoring and three observations wells were installed, and fourteen piezometers were installed in the unnamed stream and the Passumpsic River. The installation of monitoring and observation wells, in conjunction with existing monitoring wells within the Study Area and the conversion of the Curran and Riverside School wells into monitoring wells, results in a total of 92 monitoring wells. The monitoring wells were installed, based on the conceptual model, to provide hydrogeologic information and allow collection of groundwater samples for chemical analysis. Figure E-2 shows monitoring well locations.

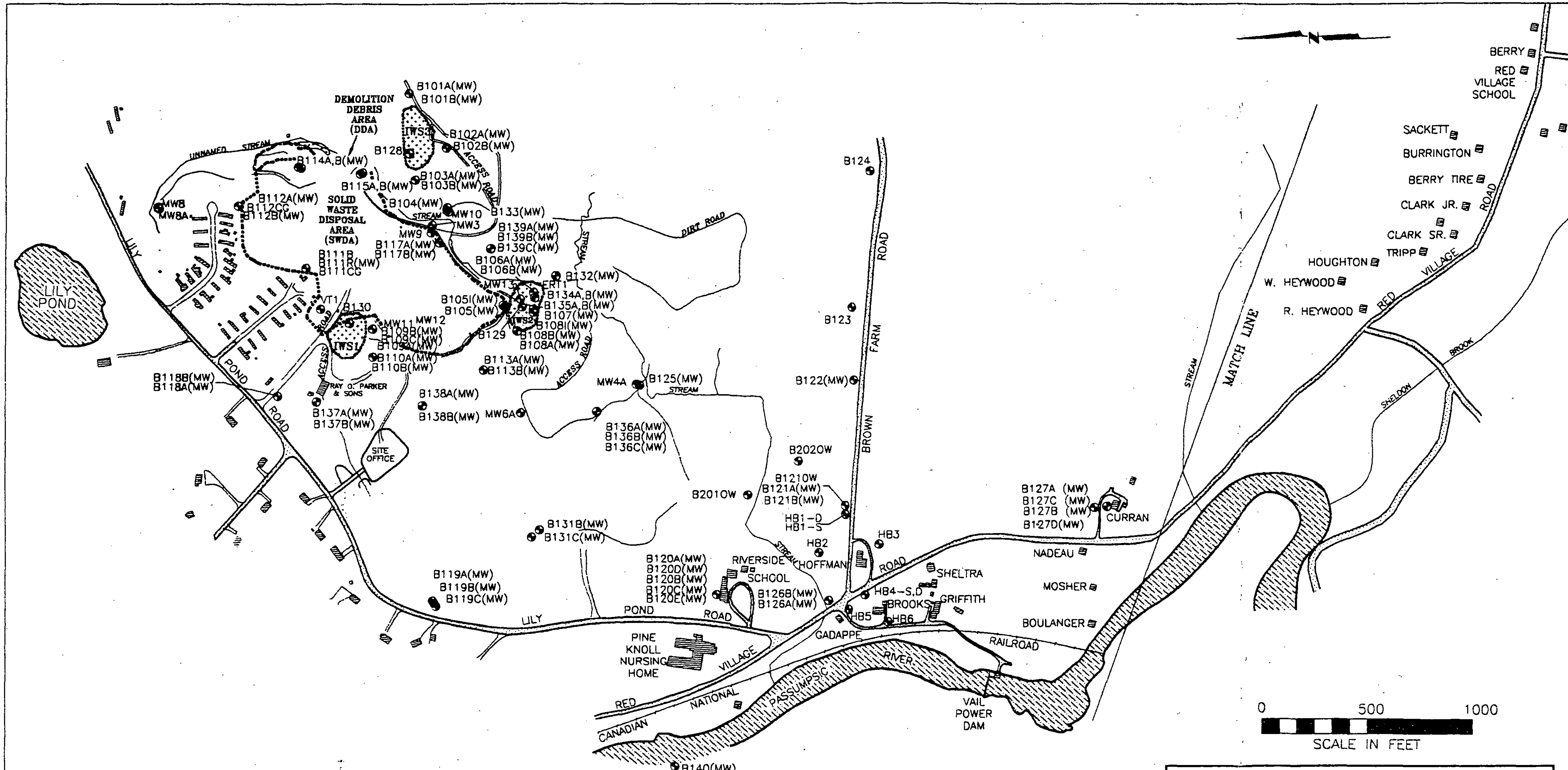
An air quality survey was performed during Phase 1A prior to beginning intrusive field work and after the completion of intrusive field work. A soil gas survey was conducted at each IWS Area to facilitate the selection of locations for test pits and borings. Surficial soil samples were collected from each IWS Area and the eastern boundary of the SWDA. Leachate from the SWDA, along the eastern boundary, was also sampled. Surface water and sediment samples were collected from the unnamed stream and a preliminary ecological assessment was conducted. Samples collected for laboratory analysis during Phase 1A were generally analyzed for the Target Compound List (TCL) organics and Target Analyte List (TAL) metals, pursuant to the requirements of the Contract Laboratory Program (CLP). Data generated by the laboratory at DQO Level 4 underwent data validation according to the EPA Region I Functional Guidelines for Data Validation.

E.3.1 GEOLOGY OF THE STUDY AREA

E.3.1.1 Surficial Geology

Four major surficial geologic deposits are of primary importance in the Study Area: esker deposits, an esker delta deposit, Proximal glacial lacustrine deposits (Proximal Units), and Distal glacial lacustrine deposits (Distal Units). An esker is located just beyond the western limit of the Study Area. The esker deposits consist of coarse to medium sand, gravel, and cobbles in graded and cross-bedded imbricated channel deposits, bounded by cross-bedded coarse to medium sand. Flow direction indicators such as cross-bedding patterns, horizontal grading, and imbrication indicate flow direction of glacial melt waters was toward the southwest, south, and southeast. Meltwater flow along the eastern flank of the esker was toward the southeast.

A west to east trending deposit of cross-bedded coarse to fine sand and gravel unit (the esker delta deposit) apparently disrupts the Distal Unit immediately south of the Landfill. Bedding



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2. SURVEY DATUM IS 1929 USGS MEAN SEA LEVEL.
3. PLAN AREA SOUTH OF MATCH LINE BASED ON USGS PROVISIONAL MAPS, BURKE MOUNTAIN AND LYNDONVILLE QUADRANGLES, 7.5 MINUTE SERIES, TO A SCALE OF 1:24000.
4. EXTENT OF IWS AND SWDA AREAS IS APPROXIMATE.

LEGEND

	SNOW FENCE (SURROUNDING IWS AREAS)
•	LANDFILL LIMIT MONUMENT
	DIRT ROAD
B130	LOCATION OF TEST BORING COMPLETED DURING 1991 AND 1992 FIELD SEASONS BY CUSHING AND SONS, INC. OF KEENE, NEW HAMPSHIRE AND ENVIRONMENTAL DRILLING, INC., OF STOWE, MASSACHUSETTS.
(MW)	INDICATES INSTALLATION OF A GROUNDWATER MONITORING WELL.
CG	INDICATES INSTALLATION OF A COMBUSTIBLE GAS MONITORING WELL.
MW10	LOCATION OF TEST BORING AND GROUNDWATER MONITORING WELL INSTALLED FOR RAY O. PARKER AND SON PRIOR TO 1987.
ERT1	LOCATION OF TEST BORING AND GROUNDWATER MONITORING WELL INSTALLED FOR ENVIRONMENTAL RESEARCH AND TECHNOLOGY, (ERT) DURING THE 1987 FIELD SEASON.

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TEST BORING/WELL LOCATIONS

FIGURE E-2

DRAWING NAME: BORWLEXE.DWG		FILE NUMBER: 490 5024	
SCALE: 1"=500'	REVISION: 0	DRAWN BY: PAD	DATE: 11/12/92

structure within the upper portion of this unit resembles deltaic top set, foreset, and bottom set beds. This unit may represent a prograding delta sequence extending in an easterly direction into a glacial lake. This unit grades northeasterly and easterly into predominantly fine sand, which is indistinguishable from the Proximal Unit.

The Proximal Unit consists of medium to fine sand and silty fine sand and extends in an easterly direction from the esker. Coarser units of coarse to medium sand were encountered at several test boring locations. The Proximal deposits are massive to thinly bedded. Grain size within the Proximal Unit decreases in an easterly direction, away from the esker. The Proximal Unit is extensive throughout the Study Area and underlies the SWDA and IWS Areas, and thickens toward the west and south. Visible bedding planes within these deposits dip toward the southeast. These deposits are interfingered with Distal Unit in the immediate vicinity of the Landfill and pinch out in an easterly direction against the underlying bedrock, which rises steeply toward the eastern highlands.

The Distal Unit, consisting of thinly interbedded to thinly interlaminated very find sand, silt, and clay overlies the basal Proximal Unit (lower Proximal) and is overlain by a shallow Proximal Unit (upper Proximal) in the immediate vicinity of the SWDA, IWS 1 and IWS 2. The Distal Unit exhibits maximum thickness immediately beneath the SWDA and decreases in thickness radially away from the SWDA. The Distal Unit deposits pinch out against bedrock along the eastern margin of the Study Area. The Distal Unit extends beyond the western boundary of the Landfill as indicated by its presence at B118 and by the existence of Lily Pond, which is interpreted to rest on Distal sediments.

E.3.1.2 Bedrock Geology

The bedrock geology of the Study Area was extensively mapped during the 1950s and 1960s by Dennis (1956) and Woodland (1965). Based upon the mappings, the Study Area is underlain by two formations: The Waits River Formation and the Gile Mountain Formation. The Waits River Formation consists of a quartzose limestone/phyllitic limestone member and an amphibolite member. The Gile Mountain Formation consists of a quartzose phyllite. The contact between the two formations is inferred to be gradational and located immediately east of the SWDA. To the east of the SWDA, the contact is inferred to trend in a northerly and southwesterly direction.

Bedrock structural data obtained in the field during the Limited Field Investigation (LFI), conducted during October 1990 to provide preliminary imputs for the RI/FS Work Plan, indicate the development of two joint sets discussed here as J_1 and J_2. J_1 generally strikes between N50°E and N60°E and dips to the northwest at 53 to 70 degrees. The trend of the occurrence of regolith, discussed previously, is coincident with the strike of the J_1 joint set and closely parallels the inferred contact between the Gile Mountain and Waits River Formations. The J_1 joints are most commonly filled with calcite and quartz. However, some of the joints observed during the LFI were open, with separations ranging from less than a tenth of an inch to one-inch in width.

J_2 strikes between N50°W and N55°W and dips toward the southwest at 67 to 80 degrees. J_2 joints striking N75°W were observed along the railroad easement near the Vail Dam and may indicate local slumping or rotation of exposed bedrock following construction of the railroad. The J_2 joints are the most common and persistent joints in the Lyndonville and Burke quadrangles and are visible as photoliners on air photographs. Published data for the Lyndonville Area (Dennis, 1956) indicate that on a regional scale the J_2 joints ar commonly not filled.

Bedrock elevations in the Study Area, determined from test borings, ranged from 723.39 to 561.9 feet above mean sea level. Contoured bedrock elevations based upon outcrop, test boring, and seismic data indicate that in the immediate vicinity of the Landfill, the bedrock surface generally dips gently toward the west. A northwest trending bedrock trough is located in the immediate vicinity of IWS 2 and extends northwest. The trend of this bedrock feature is in general agreement with the strike of the regional J_2 joint set. The bedrock topographic pattern appear to be controlled or strongly influenced by the regional J_1 and J_2 joint sets.

Test boring, rock coring, and seismic data indicate that a broad northeast-southwest trending fracture zone could exist along the eastern margin of the SWDA. Bedrock relief across the inferred fracture zone varies from approximately 120 feet at the northeast corner of the SWDA to 85 feet in the vicinity of IWS 2. Seismic data indicates the presence of a large swath of bedrock exhibiting bedrock seismic velocities that are indicative of highly weathered or fractured bedrock, which is generally 700 to 800 feet wide and extends in a southwesterly direction from IWS 3 to the Riverside School area.

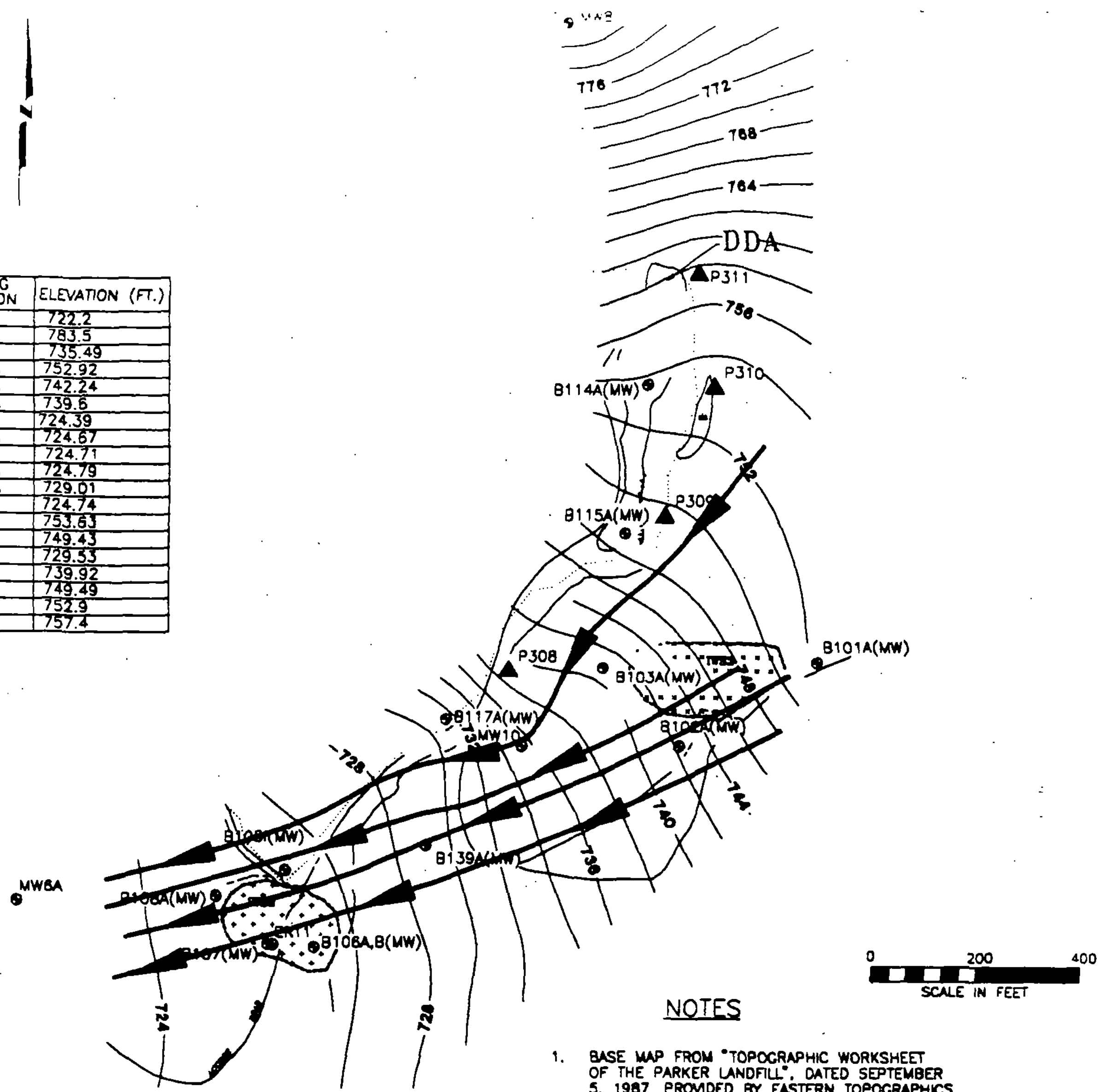
E.3.2 CONCEPTUAL MODEL OF THE STUDY AREA

Based on the results of the RI, the following summarizes the conceptual model for the Study Area:

- The Study Area is comprised of three primary hydrogeologic units: the Upper and Lower Proximal units (proximal glacial-lacustrine deposits), and the fractured bedrock. Over most of the site the Lower Proximal and fractured bedrock flow zones are separated from the Upper Proximal zone by the Distal unit (distal glacial-lacustrine deposits), which is a semi-confining unit. In terms of groundwater flow volume, the Lower Proximal zone is the principal water-bearing unit in the study area. The saturated portion of the Upper Proximal is completely contained within the Study Area and is not used for water supply. Private wells are installed in both the bedrock and the Lower Proximal, although residences in the vicinity of the Landfill are either connected to, or have access to the municipal water supply.

- South-southwesterly flow of groundwater in the upper Proximal portion of the aquifer is underlain by the lower permeability Distal Unit. This upper Proximal Unit constitutes a shallow migration pathway east of the Landfill. This preferential pathway results in the transport of VOC from IWS 3 to the general vicinity of IWS 2, as shown on Figure E-3.

- Four potential source areas within the Parker Landfill were identified during the RI: the SWDA, IWS 1, IWS 2, and IWS 3. The SWDA contains approximately



BORING LOCATION	ELEVATION (FT.)
MW6A	722.2
MW8A	783.5
MW10	735.49
B101A	752.92
B102A	742.24
B103A	739.6
B105I	724.39
B106A	724.67
B107	724.71
B108A	724.79
B139A	729.01
ERT1	724.74
B114A	753.63
B115A	749.43
B117A	729.53
P308	739.92
P309	749.49
P310	752.9
P311	757.4

NOTES

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4. INTERPOLATION OF HEAD DISTRIBUTION WAS COMPUTED ON A 25 BY 25 FOOT GRID TO ENHANCE RESOLUTION AND DETAIL. HOWEVER, THE DATA SET WAS THEN MATHEMATICALLY SMOOTHED USING A 2 BY 2 MATRIX (WEIGHTED AVERAGE) METHOD. SMOOTHING WAS PERFORMED FOR THE PURPOSE OF DE-EMPHASIZING LOCALIZED VARIATION AND TO BETTER REPRESENT THE FLOW FIELD FOR THE UPPER PROXIMAL PORTION OF THE AQUIFER AS A WHOLE.
5. PIEZOMETRIC HEADS SHOWN WERE MEASURED ON JULY 28, 1992.

LEGEND

- B130 ● LOCATION OF TEST BORING COMPLETED DURING 1991 & 1992 FIELD SEASON BY CUSHING AND SONS, INC. OF KEENE, NEW HAMPSHIRE AND ENVIRONMENTAL DRILLING, INC., OF STOWE, MASSACHUSETTS.
- (MW) INDICATES INSTALLATION OF A GROUNDWATER MONITORING WELL.
- MW10 ● LOCATION OF TEST BORING AND GROUNDWATER MONITORING WELL INSTALLED FOR RAY O. PARKER AND SON PRIOR TO 1987.
- ERT1 ● LOCATION OF TEST BORING AND GROUNDWATER MONITORING WELL INSTALLED FOR ENVIRONMENTAL RESEARCH AND TECHNOLOGY, (ERT) DURING THE 1987 FIELD SEASON.
- SNOW FENCE (SURROUNDING IWS AREAS)
- DIRT ROAD
- P311 ▲ LOCATION OF PIEZOMETER INSTALLED BY ESE PERSONNEL DURING THE 1991 FIELD SEASON.
- 772 GROUNDWATER CONTOUR. CONTOUR INTERVAL IS TWO FEET.
- STREAMLINE
- APPROXIMATE BOUNDARY OF SWDA

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PATHLINES OF TRAVEL FOR VOC IN THE UPPER PROXIMAL PORTION OF THE AQUIFER FROM IWS3

FIGURE E-3

DRAWING NAME: UPE3.DWG		FILE NUMBER: 490 5024	
SCALE: AS SHOWN	REVISION: 1	DRAWN BY: PAD	DATE: 01/18/94

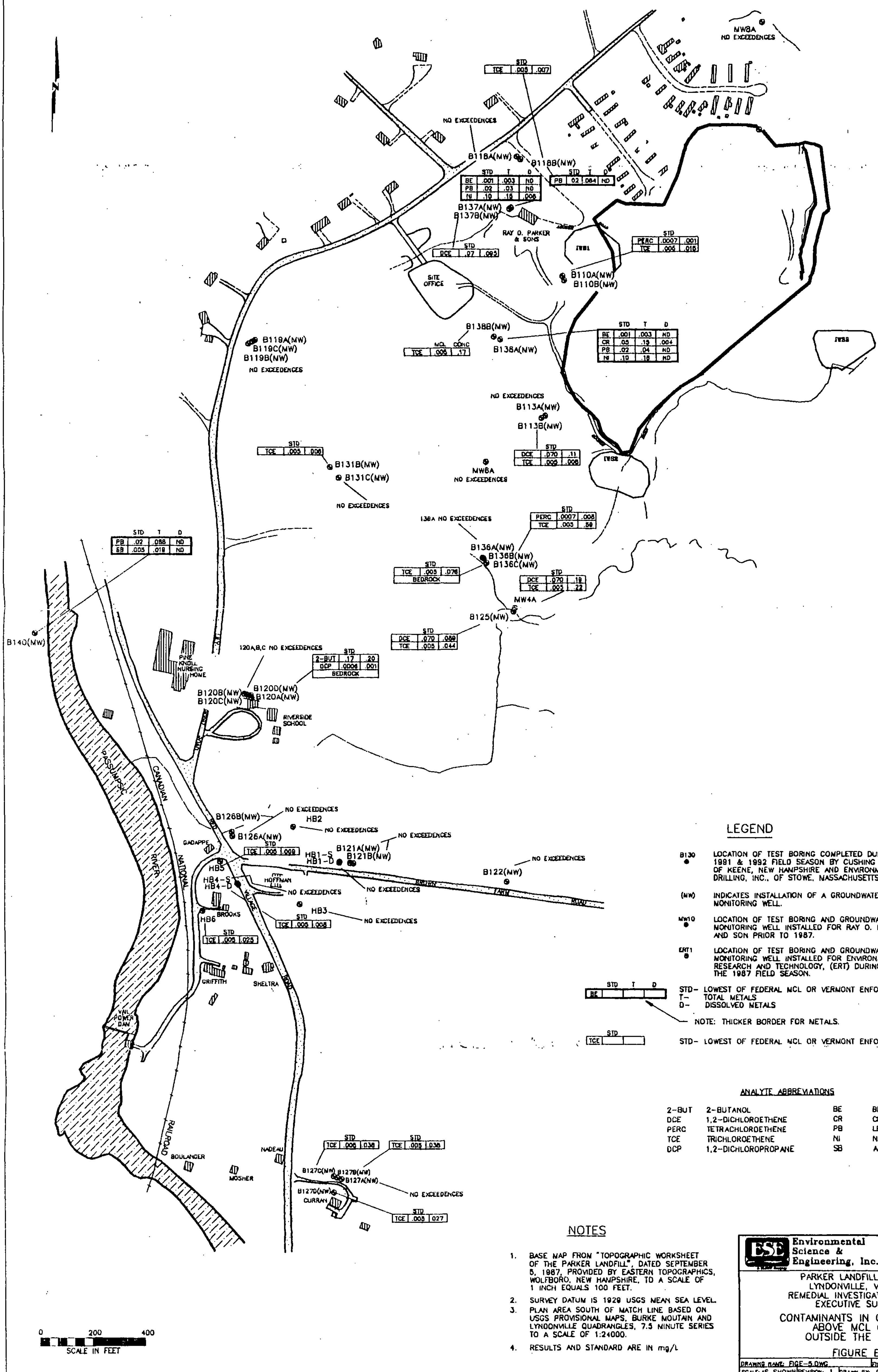
1.4 million cubic yards of solid waste and cover material. The three IWS Areas are smaller in size, and contain mixed soil and waste material including scrap metal, wood, plastic and empty, crushed drums.

- Waste in the SWDA is the source of leachate which contains mainly ketones (acetone, 2-butanone, 2-hexanone,4-methyl-2-pentanone), benzene, ethyl benzene, toluene, xylene, phenolics (methyl phenol, benzoic acid, phenol), and various metals which were detected above and below background concentrations. Individual source areas within the SWDA cannot be identified and the whole SWDA is considered to be a diffuse source.

- The organic compounds found in the upper bedrock appear to have mainly originated in IWS 3 with minor contributions from the IWS 2 area. The contribution of chlorinated organic compounds from IWS 2 to bedrock appears to be limited. Chlorinated VOC have been detected immediately above the bedrock and in bedrock beneath IWS 2, at B132, and at the B136 well cluster. However, the chlorinated VOC found at these locations cannot be readily explained by migration from IWS 2. Although the presence of a fracture zone is conjectural, based on available data, the distribution of constituents suggests that chlorinated organic compounds originating from IWS 3 enter a bedrock fracture or fracture zone, which is likely to be parallel to the trend of the J_1 joint set. This fracture zone is encountered at B132 and is hydraulically connected to the bedrock fracture zone at B136. There appears to be a bedrock hydraulic connection between IWS 2/SWDA and the Riverside School area. It is likely that this hydraulic connection consists of one or more fractures aligned consistent with the orientation of the J_1 joint set. The fractures encountered at B136, assumed to be connected to bedrock beneath B132, likely also contribute chlorinated volatile constituents to the Riverside School area, with sub-parallel fracture sets carrying mixed constituents from IWS 2/SWDA.

- Figure E-4 shows the occurrence of contaminants above either Federal Maximum Contaminant Levels (MCL) or the Vermont Enforcement Standard, in areas outside and downgradient of the Landfill. The analytical data generally suggest that the presence of the non-chlorinated VOC, detected in the overburden above MCLs, is not widespread southwest of the Landfill.

- Soil samples from the IWS Areas indicate the presence of chlorinated and petroleum-related VOC, polynuclear aromatic hydrocarbons (PAH) and metals above and below background levels. Waste materials and the majority of contaminated soil within the three IWS Areas is located above the water table. The analytical data indicate that VOC levels within IWS 2 are generally higher than in the other IWS Areas, and calculations of the relative mass of VOC within the three areas indicate that the greatest mass of "total" VOC is contained within IWS 2. By comparing the analytical data, specifically the non-chlorinated VOC concentrations with chlorinated VOC concentrations, the IWS 2 Area does not appear to be a major source of chlorinated VOC to the groundwater. Chlorinated VOC concentrations detected in shallow groundwater in the IWS 2 Area range from approximately 0.02 mg/l to approximately 0.13 mg/l, or 1 order of magnitude less than chlorinated VOC concentrations in shallow groundwater in the vicinity of IWS 1 and IWS 3. However, one well is an exception with chlorinated VOC concentrations of approximately 76.6 mg/l. It is believed that this well is in a localized area of residual organic compounds. Although chlorinated VOC are found in the soils in IWS 2, fine-grained surficial soils and fairly rapid runoff appear to limit the volume of water flushing through these soils. By comparing the concentration of chlorinated VOC in the uppermost monitoring wells, which provide an indication of contaminant concentrations leaching into groundwater from IWS 2, with chlorinated VOC concentrations in the deeper monitoring wells, which provide an indication of contaminant concentrations migrating through the subsurface from other sources, it appears that most of the chlorinated VOC found in the groundwater in the vicinity of IWS 2 may have originated from the IWS 3 Area.



LEGEND

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STD	T	D
BE		

STD- LOWEST OF FEDERAL MCL OR VERMONT ENFORCEMENT STANDARD
T- TOTAL METALS
D- DISSOLVED METALS

NOTE: THICKER BORDER FOR METALS.

	STD
TCE	

STD- LOWEST OF FEDERAL MCL OR VERMONT ENFORCEMENT STANDARD

ANALYTE ABBREVIATIONS

2-BUT	2-BUTANOL	BE	BERYLLIUM
DCE	1,2-DICHLOROETHENE	CR	CHROMIUM
PERC	TETRACHLOROETHENE	PB	LEAD
TCE	TRICHLOROETHENE	NI	NICKEL
DCP	1,2-DICHLOROPROPANE	SB	ANTIMONY

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4. RESULTS AND STANDARD ARE IN mg/L

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CONTAMINANTS IN GROUNDWATER ABOVE MCL OR VES OUTSIDE THE LANDFILL

FIGURE E-4

DRAWING NAME: FIGE-5.DWG | FILE NUMBER: 490 5024
SCALE: AS SHOWN | REVISION: 1 | DRAWN BY: PAD | DATE: 1/18/94

- Because of the complex nature of the geology in this area, and the convergence of migration pathways, separate plumes from the IWS Areas and SWDA cannot be distinguished.

- Extensive investigations during the RI defined the physical limits of waste material within IWS 1, 2, 3. These waste materials lie within the unsaturated zone. Soil containing much lower concentrations of Contaminants of Concern was also detected below the waste material in IWS 2 and 3. Some of these detections were in the saturated zone. Although saturated zone detections of Contaminants of Concern were limited in the immediate vicinity of the IWS Areas, it is possible, based on historic disposal practices, that dense nonaqueous phase liquids (DNAPL) are present within the saturated zone. The location of DNAPL, as residual or pools, if present in the subsurface, is difficult or impossible to determine. Although there is no direct evidence that DNAPL is present within the saturated zone, its potential presence must be acknowledged because of the impact this may have on the effectiveness of remedial measures.

- Similarly, overburden TCE contamination at B127B and B127C is unlikely to have resulted from transport in the overburden, given the transport times discussed in Section 5.3.4.2 of the RI.

E.4 SUMMARY OF FEASIBILITY STUDY

E.4.1 IDENTIFICATION OF RESPONSE AREAS AND REMEDIAL ACTION OBJECTIVES

Based on the data collected during the RI, and the results of the risk assessment completed by EPA, two response areas were identified for evaluation in the FS: (1) the SWDA and IWS Areas (1, 2, and 3), and (2) groundwater. The following specific remedial action objectives were identified for each response area:

SWDA and IWS Areas

- Minimize, to the extent practicable, the potential for transfer of hazardous substances from the soil and solid waste into the groundwater, surface water, and sediment;

- Prevent direct contact/ingestion of soil or solid waste posing a potential total cancer risk greater than 10^{-4} to 10^{-6}, or a potential hazard index greater than one; and

- Comply with federal and state ARARs.

The remedial objectives for the SWDA and IWS Areas are addressed by the caps which will be placed over these areas as the presumptive remedy (see section E.4.2). The caps will prevent direct contact with soil or solid waste within the SWDA and IWS Areas, and will minimize the potential for transfer of Contaminants of Concern from the unsaturated zone to groundwater through rainfall infiltration. Due to the presumptive remedy, remediation goals calculated based on exposure risk and leaching potential would only be relevant to the No Action Alternative. Therefore, remediation goals for soil in the SWDA and IWS Areas are not developed.

Groundwater

- Prevent ingestion of groundwater containing Contaminants of Concern in excess of federal or state standards, or posing a potential total cancer risk greater than 10^{-4} to 10^{-6}, or a potential hazard index greater than one; and

- Comply with federal and state ARARs.

E.4.2 PRESUMPTIVE REMEDY

Under its Superfund Accelerated Cleanup Model (SACM), EPA has established the concept of presumptive remedy as a mechanism to streamline site studies and cleanup actions, thereby, improving consistency, reducing costs, and increasing the pace at which Superfund Sites are remediated. EPA's Directive *Presumptive Remedy for CERCLA Municipal Landfill Sites* (EPA, 1993b) establishes containment (capping) as the presumptive remedy for CERCLA municipal landfills. Because there may be a potential human health risk associated with direct contact with subsurface soil and waste debris in the IWS Areas and because the SWDA, as a municipal landfill, must be closed with a cap, EPA has supported the concept of capping as the presumptive remedy for the Parker Landfill. Therefore, the FS focuses primarily on evaluating whether measures in addition to capping (i.e., groundwater control and potential hot spot remediation) may be appropriate.

As stated in EPA's *Guidance for Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites* (EPA, 1991), "hot spots that are appropriate for excavation and removal should be in discrete, accessible locations of a landfill where a waste type or mixture of wastes presents a principal threat to human health or the environment. The area should be large enough so that remediation will significantly reduce the risk posed by the overall site and small enough to be reasonably practicable for removal and/or treatment." To evaluate the potential significance of each IWS Area as a "hot spot," as mentioned previously, the relative amounts of VOC in IWS 1, IWS 2, and IWS 3, presented on the basis of mass, were calculated. The results of this analysis indicate that IWS 3 only contains 14% of the total VOC mass, and IWS 1 only contains 7% of the total VOC mass estimated to exist in the three IWS Areas. Therefore, removal of the VOC mass from IWS 1 or IWS 3 would not significantly reduce the risk posed by the site. Furthermore, these areas will be capped in accordance with the presumptive remedy, and rainfall infiltration and percolation from these areas will be prevented. IWS 2, however, contains 79% of the mass of "total" VOC within the IWS Areas. Based on this analysis, in accordance with EPA guidance, of the three IWS Areas, only IWS 2 was considered as a potential "hot spot" and evaluated for potential removal and treatment or disposal.

E.4.3 PRELIMINARY AND INITIAL SCREENING OF ALTERNATIVES

During the preliminary screening, the general response measures considered applicable for each of the identified response areas were identified. For each general response measure, remediation technologies, and processes specific to these technologies, were then identified. A preliminary screening of these technologies and specific processes was conducted to determine their applicability and technical feasibility. Those remedial technologies considered ineffective or unsuitable for implementation were eliminated from further consideration during the preliminary technology screening. Then, in order to simplify the subsequent development and evaluation of alternatives without limiting flexibility during remedial design, representative technologies/process options were selected.

The representative technologies/process options that remained after the preliminary screening were developed into potential remedial alternatives. The remedial alternatives for Groundwater and the SWDA and IWS Areas at the Parker Landfill are:

Alternative 1:	No Action;
Alternative 2:	Containment (SWDA, IWS 1, 2 and 3)/No Source Control Groundwater Extraction;
Alternative 3:	Containment (SWDA, IWS 1, 2 and 3)/Source Control Groundwater Extraction;
Alternative 4:	Containment (SWDA, IWS 1, 2 and 3)/In-situ Soil Vapor Extraction of IWS 2 Area/No Source Control Groundwater Extraction;
Alternative 5:	Containment (SWDA, IWS 1, 2 and 3)/In-situ Soil Vapor Extraction of IWS 2 Area/Source Control Groundwater Extraction;

Alternative 6: Containment (SWDA, IWS 1 and 3)/Excavation and Off-site Incineration of IWS 2 Materials/No Source Control Groundwater Extraction;

Alternative 7: Containment (SWDA, IWS 1 and 3)/Excavation and Off-site Incineration of IWS 2 Materials/Source Control Groundwater Extraction; and

Alternative 8: Downgradient Groundwater Extraction/Treatment/ Discharge (may be combined with Alternatives 2 through 7).

Alternative 8A: Downgradient Groundwater Extraction/Combined with Alternatives 2, 4, or 6 (No Source Control Groundwater Extraction System).

Alternative 8B: Downgradient Groundwater Extraction/Combined with Alternatives 3, 5, or 7 (Source Control Groundwater Extraction System).

An initial screening evaluation, which consisted of an evaluation of each alternative's effectiveness and implementability, was conducted on each of the potential remedial alternatives. Those alternatives that would have significant adverse impacts or would not adequately contribute to the protection of public health or the environment were eliminated from further consideration. In addition, an order of magnitude cost comparison between alternatives that would provide a commensurate level of protection to public health and the environment was conducted.

Two alternatives were eliminated during the initial screening. Alternative 6: Containment (SWDA, IWS 1 and 3)/Excavation and Off-Site Incineration of IWS 2 Materials/No Source Control Groundwater Extraction, and Alternative 7: Containment (SWDA, IWS 1 and

3)/Excavation and Off-Site Incineration of IWS 2 Materials/Source Control Groundwater Extraction were eliminated because they would offer very limited additional benefits and minimal risk reduction relative to other alternatives, yet would be more costly to implement and would pose significant potential worker and community exposure and implementability concerns.

Alternatives 4 and 5 were retained for further evaluation as a VOC-reduction measure, because it is the presumptive remedy for CERCLA Sites with VOC in soils (EPA 540-F-93-048) and the National Contingency Plan (NCP) and EPA guidance specify that the range of alternatives to be considered includes treatment alternatives, to the extent practicable. EPA presumptive remedy guidance states, however, that vacuum extraction may or may not be appropriate for VOC-contaminated soils, depending on site-specific conditions.

E.4.4 DETAILED EVALUATION

A detailed evaluation, based on seven of the nine criteria enumerated in the NCP, was conducted on the remedial alternatives remaining after the initial screening. The remaining two criteria (state and community acceptance) will be evaluated by EPA following public comment. The following alternatives were evaluated in detail in the FS:

Alternative 1:	No Action
Alternative 2:	Containment (SWDA, IWS 1, 2, and 3)/No Source Control Groundwater
Alternative 3:	Containment (SWDA, IWS 1, 2, and 3)/Source Control Groundwater
Alternative 4:	Containment (SWDA, IWS 1, 2, and 3)/In-Situ Soil Vapor Extraction Within IWS 2/No Source Control Groundwater
Alternative 5:	Containment (SWDA, IWS 1, 2, and 3)/In-Situ Soil Vapor Extraction Within IWS 2/Source Control Groundwater
Alternative 8:	Downgradient Groundwater Extraction/Treatment/Discharge (may be combined with Alternatives 2 through 5)

Alternative 8A: Downgradient Groundwater Extraction/Combined with Alternatives 2 or 4 (No Source Control Groundwater Extraction System).

Alternative 8B: Downgradient Groundwater Extraction/Combined with Alternatives 3 or 5 (Source Control Groundwater Extraction System).

The strengths and weaknesses of the alternatives relative to one another, with respect to each criterion, are:

- *Overall Protection of Human Health and the Environment*

  All of the alternatives except for the No Action Alternative provide a similar level of human health protection with respect to the potential for direct contact with soil and solid waste material, since they all include the construction of caps and deed restrictions to protect cap integrity. There would be some potential short-term risk of exposure to soil and solid waste material during cap construction and any demolition debris relocation under all of these alternatives. There would be a greater level of potential short-term risk to workers associated with Alternatives 4 and 5, since they would also involve construction of a soil vapor extraction system in IWS 2.

  All of the alternatives, except for "No Action", would include institutional controls to prevent the ingestion of groundwater that may pose a health risk. Cooperation from the State, municipality and the public are required to implement these controls. Residences downgradient of the SWDA and IWS Areas where Contaminants of Concern have been detected are currently, or have the option of being connected to the Village of Lyndonville's municipal water supply.

  Implementation of capping measures alone, without a groundwater extraction measure (Alternative 2), would effectively eliminate the migration of constituents via infiltration from SWDA and IWS Area sources located above the water table, and therefore would result in an improvement in downgradient groundwater quality. The extent to which potential source materials in the saturated zone may continue to impact groundwater cannot be determined. Therefore, the degree of groundwater quality improvement and timeframe for reduction of levels to remediation goals is unpredictable within the foreseeable future.

If a source control groundwater extraction measure (Alternatives 3, 5, and 8B) and/or a downgradient extraction system (Alternatives 8A and 8B) was also included, there would be only a small improvement in overall human health protectiveness relative to Alternative 2, since protection would be accomplished through institutional controls for approximately 60 years (downgradient of the source control extraction system) or more (within the SWDA and IWS Areas). Under Alternatives 3 and 5, the migration of impacted groundwater from the SWDA and IWS Areas would be prevented and additional improvement in downgradient groundwater quality would occur. However, the timeframe for reduction of levels in groundwater within the area contained by the source control extraction system is unpredictable within the foreseeable future. Groundwater standards would not be reached downgradient of the source control groundwater extraction system for approximately 60 years after the system was in place. Implementation of a downgradient extraction system (Alternatives 8A and 8B) would contain the known downgradient extent of the contaminant plume but would not accelerate the reduction of constituent levels in impacted groundwater.

Installation and operation of a soil vapor extraction system within IWS 2 (Alternatives 4 and 5) would not significantly reduce human health risks or impacts to groundwater, since the cap alone would prevent migration of constituents from the unsaturated zone within IWS 2.

The physical impacts to wetlands under Alternatives 2 through 8 would be similar, and would be primarily associated with filling as a result of cap construction. The design of the caps for the SWDA and IWS Areas may incorporate waste reconfiguration to minimize wetlands impacts and will include a storm water control system including a detention pond which could incorporate wetlands mitigation after establishment of vegetative cover on the cap system. Under all of the alternatives which incorporate a cap (Alternatives 2, 3, 4, 5 and 8) there would be a reduction of erosion and sedimentation impacts to the stream and sediment relative to Alternative 1.

- *Compliance with ARARs*

Alternative 1 (No Action) generally does not comply with chemical-, action-, or location-specific ARARs. In contrast, Alternative 2 will meet both action-specific and location-specific ARARs and portions of chemical-specific ARARs. However, this alternative will not comply with federal or state groundwater standards, such as the maximum permissible concentrations of hazardous constituents in groundwater established by the state or the federal MCLs, for Contaminants of Concern.

For any of the alternatives, concentrations of Contaminants of Concern may remain above groundwater standards within the SWDA and IWS Areas for an unpredictable timeframe, although for Alternatives 2 through 8, the levels would reduce due to the effects of the caps and groundwater flushing, dispersion, and natural degradation processes. Alternatives 3, 5, and 8B include a source control groundwater extraction system. Even with the source control groundwater extraction system, groundwater concentrations of Contaminants of Concern in the SWDA and IWS Areas will not attain ARARs, and downgradient of the system, concentrations are estimated to take approximately 60 years, following installation and start-up, to meet ARARs for these alternatives.

Similar to Alternative 2, Alternatives 3 through 8 also comply with action- and location-specific ARARs.

- *Long-Term Effectiveness and Permanence*

The magnitude of residual risk associated with the potential for direct contact with Contaminants of Concern in soil and debris would be similar under Alternatives 2, 3, 4, 5, and 8 because they include a cap. Cap systems are proven, in general, to perform reliably in the long-term. Alternative 1 would not address the potential for exposure to Contaminants of Concern in soil and debris.

Although there would be some improvement in groundwater quality associated with cap installation under any of the alternatives (except for Alternative 1), the degree of groundwater quality improvement and time to achieve groundwater standards beneath the SWDA and IWS Areas is not predictable for the foreseeable future under any of the alternatives. Under alternatives including a source control groundwater extraction system (Alternatives 3, 5 and 8B), and/or a downgradient extraction system (Alternatives 8A and 8B), a remediation timeframe can be calculated for groundwater downgradient of the source control extraction system, since the extraction system would prevent the movement of contaminated groundwater beyond the SWDA and IWS Areas and allow downgradient groundwater levels to reduce at a predictable rate. However, calculations indicate that levels within this area would not reduce to groundwater standards for approximately 60 years after a system was in place, even if a downgradient extraction system is included. Therefore, in the long term, under any of the alternatives except for No Action, protectiveness would be achieved primarily through institutional controls preventing groundwater use. Institutional controls can perform reliably in the long-term, although they require the cooperation of the State, municipality and the public. Residences downgradient of the SWDA and IWS Areas where Contaminants of Concern have been detected are currently, or have the option of being connected to the Village of Lyndonville's municipal water supply.

Although there have been effectiveness problems associated with the use of extraction and treatment systems for aquifer remediation, extraction systems have been used reliably as containment systems which hydraulically prevent contaminant migration. The source control extraction treatment system would need to remain in operation for an indeterminant time period (beyond 60 years) to maintain downgradient groundwater quality improvement. Extraction well fouling can be addressed by routine maintenance and monitoring. The groundwater treatment system would generate considerable amounts of residual materials, as compared to the Contaminants of Concern treated, which would require off-site treatment or disposal.

The operation of an SVE system in IWS 2 would not significantly improve the long-term effectiveness of remedial measures relative to other Alternatives that include a cap (Alternatives 2, 3 and 8 without SVE). The caps would reliably prevent direct contact with and leaching from Contaminants of Concern within the unsaturated zone in IWS 2. Even under current conditions, waste materials within the unsaturated zone in IWS 2 do not appear to be significantly impacting groundwater. The long-term effectiveness of the SVE system may be limited due to the presence of low permeability soils and the presence of debris, which could cause VOC removal along preferential pathways and leave contaminants in high concentration areas. Some VOC would be permanently removed from soil at IWS 2; however, residual material from the operation of the SVE system would require off-site treatment or disposal.

- *Reduction of Toxicity, Mobility, and Volume through Treatment*

The degree of expected reduction in toxicity, mobility and volume (TMV) through treatment cannot be calculated for any of the alternatives because the total contaminant mass associated with source materials within the SWDA and IWS Areas cannot be accurately determined. Similarly, the degree to which treatment would reduce the inherent hazard posed by Contaminants of Concern in the SWDA and IWS Areas cannot be reliably estimated; however, this reduction would be minimal, since the human health and environmental risk associated with Contaminants of Concern in the SWDA and IWS Areas would be primarily controlled through capping and institutional controls. Although groundwater extraction and treatment under Alternatives 3, 5 and 8 would remove toxicity from the groundwater, the timeframe for reduction of levels in groundwater within the SWDA and IWS Areas is unpredictable within the foreseeable future. Downgradient of the extraction system, groundwater standards would not be reached for approximately 60 years. Therefore, under any alternative, the risk of exposure to groundwater will be primarily controlled through implementation of institutional restrictions on groundwater use.

Under Alternative 2, although groundwater quality would improve, the toxicity of Contaminants of Concern would not be reduced through treatment, and treatment residuals would not be generated. Under Alternatives 3, 5, and 8, the toxicity of Contaminants of Concern in extracted groundwater would be reduced through treatment and under Alternatives 4 and 5 and the medium and high cost scenarios for 8A and 8B, VOC would be removed from IWS 2 by the soil vapor extraction system. However, the toxicity would be transferred to treatment residuals which would then require appropriate treatment/disposal, perhaps as hazardous material. Alternatives 3 and 5 would generate an estimated 4.6 tons/year spent carbon and 427 tons/year dewatered metal sludge; Alternative 8B would generate an estimated 6.7 tons/year spent carbon and 536 tons/year dewatered metal sludge; Alternative 8A would generate an estimated 5.2 tons/year spent carbon and 161 tons/year dewatered metal sludge. Alternatives including a soil vapor extraction system would generate approximately 3 tons/year of spent carbon from this system.

- *Short-Term Effectiveness*

Most of the alternatives would provide a similar level of protection of the community and workers during remedial action implementation. Alternative 1 (No Action) would pose the lowest potential risk to the community and workers during remedial action implementation. Potential short-term risks associated with Alternatives 2, 3, and 8 would be small, and would be primarily associated with construction of the cap and any relocation of demolition debris, and for alternatives involving extraction and treatment of groundwater construction of the discharge pipeline to the Passumpsic River. Alternatives 4 and 5 and possibly 8A and 8B would pose a greater potential short-term exposure risk, since they may also involve construction of an in-situ SVE system within IWS 2.

Under all of the alternatives except for Alternative 1, wetlands impacts would be primarily associated with construction of the cap. In the northern portion of the site, a portion of the Unnamed Stream may be routed through a culvert beneath the cap or relocated adjacent to the SWDA cap. However, the design of the caps for the SWDA and IWS Areas would include a storm water system, including a detention pond, which could incorporate wetlands mitigation.

Protection would not be achieved by Alternative 1, since exposure to soil and debris that may pose a health risk would not be prevented. Under Alternatives 2 through 8, protection would be achieved in the short and long term, primarily through capping and institutional controls. The potential for exposure to soil and solid waste that may contain Contaminants of Concern under Alternatives 2 through 8 would be eliminated immediately after construction of the cap. Short-term protectiveness, with respect to exposure to groundwater under Alternatives 2, 3, 4, 5 and 8, would be achieved through the implementation of institutional controls preventing impacted groundwater use.

Although there would be some short-term improvement in groundwater quality, compared with No Action due to the presence of the caps (Alternatives 2 through 8) and groundwater extraction and treatment systems (Alternatives 3, 5, and 8), there will be no short-term attainment of groundwater remedial goals with any alternative.

The implementation time for Alternative 1 would be minimal, since the No Action alternative only involves performing a five-year site review. It has been estimated that Alternative 2 would take approximately 24 months to implement, and Alternative

4 would take approximately 27 months. The estimated implementation time for the remaining alternatives is approximately 34 months.

- *Implementability*

Alternative 1 would be the easiest to implement, since it would only involve performing a five year site review. Construction and maintenance of the caps under Alternatives 2 through 8 could be implemented without significant difficulty, as services and materials are available. Caps have been demonstrated to be reliable at many sites. Periodic inspections of the caps to ensure that they continue to effectively prevent direct contact with soil and solid waste containing Contaminants of Concern above remediation goals would be necessary. Groundwater monitoring and institutional controls, also included in Alternatives 2 through 8, could be easily implemented. Groundwater monitoring is ongoing and could be continued. Institutional controls would be readily implemented since a public water supply is available to the impacted area, although the cooperation of landowners, the Town, and the State of Vermont would be required.

Installation and operation of the extraction wells, treatment system, and discharge pipeline to the Passumpsic River would utilize standard construction services, techniques, and materials, which would be available, and these systems should perform reliably. Measures would need to be taken to minimize the potential for remobilization of subsurface nonaqueous-phase contaminants, if they exist, during well installation and pumping. Initial calculations of the potential discharge limits for some metals based on available attenuation of the Passumpsic River showed values which may be difficult to technically attain. Appropriate handling and disposal of groundwater treatment system residuals would be necessary. Easements would be required for construction of the discharge pipeline, and compliance with substantive requirements of the NPDES program would be necessary for discharge of the treated groundwater to the Passumpsic River.

Vacuum extraction systems have been implemented at other sites. However, SVE may be difficult to implement successfully in IWS 2. Due to the low permeability of soil and presence of buried debris in IWS 2, it may be difficult to achieve adequate and/or homogeneous air flow, which can cause VOC constituents to be eliminated sporadically, with high concentrations remaining in lower permeability zones. Removal and treatment of residual materials from operation of the SVE treatment system would require appropriate handling and off-site disposal.

As discussed above, Alternatives 3, 4, 5, and 8 would involve the off-site disposal of treatment residuals. The nearest lined hazardous waste disposal facilities are located in New York, Ohio, Indiana, and Maine. Waste transportation to these facilities can be expensive, and some of these landfills also have restrictions in accepting hazardous waste. The long-term availability of such facilities is uncertain, since only a few have been permitted in recent years; off-site disposal capacity would be needed for a time period that is unpredictable in the foreseeable future.

- *Cost Analysis*

Alternative 1 would be the least costly to implement ($40 to $50 thousand total present worth with a medium-case present worth cost estimate of $40 thousand; total present worth costs are rounded to the nearest $10,000), since it would only involve performing a five-year site review. The estimated total present worth cost to implement Alternative 2 could range from $10.4 to $19.3 million, with a medium-case cost estimate of $13.6 million. The costs for this alternative would be principally associated with the construction of caps over the SWDA and IWS Areas. If in-situ soil vapor extraction within IWS 2 is also included (Alternative 4), this would add $1 million or more to the total present worth cost estimate. The total present worth cost range for Alternative 4 is estimated at $11.8 million to $22.1 million (the estimated medium-case present worth cost is $15.5 million). The costs specifically associated with implementation of the SVE system would vary depending on the air flow and mass-loading rates.

The costs associated with the remaining alternatives (Alternatives 3, 5, 8A, and 8B) would be significantly (100% or more) higher because they involve the extraction, treatment, and discharge of groundwater. The estimated total present worth costs for Alternative 3 (capping with source control groundwater extraction) would range from $19 to $38 million, with a medium-case cost estimate of $28.2 million. Alternative 5 (which also includes SVE within IWS 2) low, medium, and high total present worth cost estimates are $20.4, $30 and $40.7 million, respectively. The range of costs associated with Alternative 8A, which includes capping and downgradient groundwater extraction, and possibly also SVE within IWS 2, is $18.8 to $39.1 million (total present worth). The medium-case cost estimate for this alternative is $28.4 million. The low- and medium-case cost estimates for Alternative 8B are $21.5 million (combined with the low case of Alternative 3) and $32.5 million (combined with the medium-case of Alternative 5), respectively. The most expensive alternative to construct and operate would be Alternative 8B (capping, downgradient groundwater extraction, and source control groundwater extraction) with in-situ soil vapor extraction within IWS 2. The total present worth costs for this alternative could range up to $43.4 million.

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1.0 INTRODUCTION

This report presents the Feasibility Study (FS) completed for the Parker Landfill (the Landfill) Project pursuant to the requirements of U.S. Environmental Protection Agency (EPA) Administrative Order by Consent, Docket Number I-90-1089 (Order), effective August 10, 1990 entered into between the EPA and certain potentially responsible parties ("PRPs").

This study was conducted in accordance with the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986 and its governing regulations, the National Contingency Plan (NCP), 40 CFR 300. The NCP provides decision making guidance and a framework for the identification, evaluation, and screening of remedial action alternatives on a case-by-case basis. In addition, the procedures enumerated in the *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA, 1988a), *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites* (EPA, 1991), *Presumptive Remedies Policy and Procedures* (EPA, 1993a), and *Presumptive Remedy for CERCLA Municipal Landfill Sites* (EPA, 1993b) were followed. Because the site includes a former municipal landfill, one of many in EPA Region 1 for which site studies and remedial measures have been completed, the Feasibility Study incorporates the presumptive remedy approach for municipal landfill sites in accordance with EPA's Superfund Accelerated Cleanup Model (SACM).

This FS document is the second of two components to the RI/FS which are being submitted simultaneously. The first component is the Remedial Investigation Report. The FS is presented in two volumes - Volume 1, which contains the Feasibility Study text, figures, and tables, and Volume 2, which contains Appendices A-G.

1.1 FEASIBILITY STUDY PROCESS

The FS process provides for the development and evaluation of potential remedial alternatives that may be applicable for remediation of a given site. This FS evaluation is based upon the

Remedial Investigation Report (RI) (ESE, 1992), including the *Post-Screening Field Investigation*, part of the *Final Remedial Investigation Report* (ESE, 1994), and the *Baseline Health Risk Assessment* (HRA) (EPA, 1992). The RI evaluates the nature and extent of a potential problem at a specific location, and the HRA provides the basis upon which the need for remedial measures is assessed and remediation goals are developed. The results of the FS detailed evaluation, which incorporates the presumptive remedy approach as suggested and supported by EPA (see Section 1.6), along with risk-management judgements, will provide EPA with a basis for selection of a preferred alternative and preparation of a proposed plan for the Parker Landfill Project.

The FS process involves several development and evaluation steps for alternatives. First, potential response areas are identified and possible remedial response objectives are developed. Next, general response measures that have the potential to meet the response objectives are identified. For each general response measure, remediation technologies and processes specific to these technologies are then identified. A preliminary screening of these technologies and specific processes is conducted to determine their applicability and technical feasibility. Those remedial technologies considered ineffective or unsuitable for implementation are eliminated from further consideration during the preliminary technology screening. In addition, technologies that have not been fully demonstrated and do not appear promising, or whose use would be precluded by location characteristics, are also eliminated from further consideration. Technologies/process options remaining after the preliminary screening step are evaluated with respect to their effectiveness, implementability, and relative costs. Based on this evaluation, representative process options are selected in order to simplify the subsequent development and evaluation of alternatives without limiting flexibility during remedial design.

The representative technologies/process options that are selected from the preliminary screening are developed into potential remedial alternatives. In the development of the remedial alternatives, acceptable engineering practice, as well as applicable environmental standards, are considered, as appropriate. An initial screening evaluation, which consists of an evaluation of each alternative's effectiveness and implementability, is conducted on each of the potential remedial alternatives. Those alternatives that have significant adverse impacts or do not adequately contribute to the protection of public health or the environment are eliminated from further consideration. In addition, an order-of-magnitude cost comparison between alternatives that would provide a commensurate level of protection to public health and the environment is conducted.

A detailed evaluation, based on seven of the nine criteria enumerated in the NCP, is conducted on the remedial alternatives selected in the initial screening evaluation. The detailed evaluation includes an assessment of each alternative's feasibility, overall effectiveness, and cost, as follows:

1. Overall protection of human health and the environment;
2. Compliance with Applicable or Relevant and Appropriate Requirements (ARARs);
3. Long-term effectiveness and permanence;
4. Reduction of toxicity, mobility, or volume through treatment;
5. Short-term effectiveness;
6. Implementability; and
7. Cost.

Two additional criteria, State acceptance and community acceptance, will be evaluated by EPA following the public comment period on the proposed plan.

These nine criteria can be categorized into three groups, as follows:

1. <u>Threshold criteria</u>, which include overall protection of human health and the environment, and compliance with ARARs. Unless a specific ARAR is waived, each alternative must meet these criteria in order to be eligible for selection;

2. <u>Primary balancing criteria</u>, which include long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost; and

3. Modifying criteria, which include State and community acceptance. These modifying criteria are evaluated following the selection of a remedy.

Comparison of each alternative based upon the nine criteria described in the NCP provides the basis from which a remedial action plan is developed.

1.2 BACKGROUND

1.2.1 History

The vicinity of the Parker Landfill was used as a gravel pit and town disposal area starting in the late 1950s and was first approved as a disposal facility for solid waste on July 17, 1971 by the District No. 7 Environmental Commission and Land Use Permit No. 700002. Approval for a sanitary landfill under the authority of the Vermont Health Regulations was granted on October 20, 1971. Formal operation of the Parker Landfill by Ray O. Parker & Sons, Inc. began in 1972. The municipal landfill or Solid Waste Disposal Area (SWDA) accepted municipal solid waste with some quantities of hazardous waste. At various times during the Parker Landfill operation, three additional and separate areas of the property were utilized for disposal of industrial wastes (Industrial Waste Disposal Areas (IWS) 1, 2, and 3). The industrial wastes disposed within these areas included waste oils, chlorinated solvent sludges, metal plating rinse waters, and other miscellaneous industrial wastes. Waste disposal in the IWS Areas ceased in 1983, whereas waste continued to be disposed of within the SWDA until July 1992.

Investigation of the Parker Landfill by the Vermont Agency of Environmental Conservation (VAEC, now the Vermont Department of Environmental Conservation, VTDEC) began in 1984 when routine sampling by the VAEC revealed the presence of chlorinated volatile organic compounds (VOC) in monitoring wells at the Parker Landfill and in stream locations on the eastern perimeter of the Parker Landfill. Subsequent sampling detected very low levels of a few VOC in five private wells located south of the Parker Landfill. During 1985, VAEC completed a *Preliminary Assessment* (VAEC, 1985a) and an *Uncontrolled Hazardous Waste Site Evaluation* *of the Parker Landfill* (VAEC, 1985b). Based upon the results of those studies, the Parker Landfill was included on the National Priorities List in 1990.

1.2.2 Description

The Parker Landfill includes the SWDA and three smaller IWS Areas (1, 2, and 3) (Figure 1-1). The SWDA contains approximately 1.4 million cubic yards of solid waste and cover material and occupies approximately 14 acres. The SWDA has an average thickness of approximately 70 feet. This estimate was derived from estimates of the pre-landfill topography and the existing surface topography of the SWDA. Test boring data from borings along the perimeter of the SWDA indicate that along the western margin of the SWDA the water table is approximately 60 to 100 feet below the bottom of the waste mass. Along the eastern margin of the SWDA, the distance between the water table and the waste ranges from approximately 4.5 feet at the northeastern terminus of the SWDA to 15 feet at the southeastern terminus of the SWDA. Water level measurements taken in the fall, spring and summer indicate water level fluctuations are sufficiently small so that the water table is not expected to be in contact with the SWDA wastes at any of the boring locations discussed above. Water level fluctuations of less than one foot were observed in monitoring wells located on the northeast edge of the SWDA (MW-14A, MW-15A) and the southeast edge of the SWDA (MW-106A). A maximum water level fluctuation of approximately 1.5 feet was observed in MW-17A, located on the eastern side of the SWDA, about halfway between the northern and southern boundaries.

IWS 1 is located along the Parker Landfill access road, on the western side of the SWDA and covers a surface area of approximately 14,800 square feet (0.33 acres). This disposal area was used from 1972 until 1977. Ground-penetrating radar (GPR) and test pit data indicate waste depths across IWS 1 range from approximately five to eleven feet. The approximate volume of waste material within IWS 1 is 6,000 cubic yards.

Test pit excavations within IWS 1 encountered mixed soil and waste material consisting of brown medium to fine sand with abundant scrap metal, metal turnings, pipe, and 55-gallon drums. The 55-gallon drums encountered in the test pits were open, crushed, and empty. No intact drums were encountered in any of the test pits. A test pit completed along the eastern limit of IWS 1 encountered a one foot thick veneer of metal shavings overlying 5.5 feet of solid waste (household rubbish). Quantities of municipal solid waste were also encountered during the construction of a decontamination pad along the northern perimeter of IWS 1, indicating that a small portion of IWS 1 abuts or overlies the footprint of the SWDA.

Data from borings within and adjacent to IWS 1 indicate the water table is located approximately 100 feet below the ground surface, approximately 85 feet below the bottom of the IWS 1 waste material. The unsaturated zone beneath IWS 1 primarily consists of thinly interbedded to thinly interlaminated silt, fine sand, and clay.

IWS 2, located at the extreme southeastern tip of the SWDA, approximately 200 feet west of a small perennial stream (the Unnamed Stream) was used in 1977 and 1978. The mixed soil and waste material in IWS 2 consists of brown to black, fine to coarse sand with little silt, trace gravel, metal wire, crushed buckets, metal turnings, wood, and crushed drums. No intact buckets or drums were encountered in any of the test pits or borings. GPR and test pit data indicate the waste mass extends to a depth of 3.5 to 7.5 feet below the ground surface. Based on these data, the volume of waste contained within IWS 2 is approximately 2,000 cubic yards. Groundwater monitoring data indicate the water table is approximately 10.5 feet below the bottom of the waste mass. IWS 2 is underlain by interbedded fine sand, silt, and clay.

The third industrial waste disposal area, IWS 3, is more remote than the others from the SWDA. It is located on a wooded hill east of the SWDA across the Unnamed Stream. This area was utilized between 1978 and 1983. Metal turnings and scrap metal are present at the ground surface across the northwestern portion of IWS 3. Test pit and test boring data indicate the mixed soil and waste material extends to a depth of 4.8 to 8.5 feet below the ground surface and consists of brown to black silty fine sand to coarse to fine sand with gravel and metal cuttings, wood, plastic, and crushed drums. No intact drums were encountered in any test pits or borings. Based on these data and a geophysical investigation, the volume of waste that may be present in IWS 3 is approximately 2,000 cubic yards.

Test boring data from within and adjacent to IWS 3 indicate the water table is located approximately 46 feet below the ground surface, approximately 37.5 feet below the bottom of the waste mass. The IWS 3 vicinity is underlain by very fine sand to a depth of approximately 36 to 50 feet below the ground surface. Silt and clay deposits underlie the very fine sand unit. The water table appears to closely correlate with the location of the interface between the very fine sand unit and the silt/clay unit.

The area in the immediate vicinity of the Parker Landfill is open, mainly unvegetated, hilly terrain. To the north, approximately 0.3 mile from the Parker Landfill, are three mobile home communities and seven single family homes (Figure 1-1). To the north of these houses, beyond Lily Pond, is a combination of pasture land, crop land, and woodland. Approximately one-half mile to the west is a combination of woodland and a residential development (approximately 40 homes). To the south is a combination of woodland, pasture land, and crop land. A private school, a nursing home, and five single-family homes are located about 0.5 mile south of the Parker Landfill. East of the Parker Landfill are hilly woodlands and the Unnamed Stream. Small wetland areas are also associated with the stream.

The Village of Lyndonville operates a municipal water system supplying water to the residences north and west of the Parker Landfill (including the trailer parks), the nursing home, and the housing development west of the Parker Landfill. An extension of that water line was installed in the fall of 1991, extending the availability of municipal water to homes along Red Village Road, approximately 1,200 feet from the intersection with Brown Farm Road (Figure 1-1). Ten residences south of the Parker Landfill have access to or are currently connected to this new water line. Eleven additional residences, with private supply wells, are located further along Red Village Road, between 1,500 and 3,000 feet east of the Curran residence. It is estimated that private wells within a three mile radius of the Parker Landfill serve a population of approximately 500.

1.2.3 Summary of Remedial Investigation

The RI and post-screening field investigation, conducted during the 1991, 1992, and 1993 field seasons, investigated the SWDA, IWS Areas, and groundwater conditions, and included:

- Geophysical investigations;

- Air quality survey;
- Soil vapor survey;
- Completion of 32 test borings;
- Installation of 50 monitoring and ten observation wells;
- Installation of 14 piezometers;
- Installation of two pumping wells;
- Performance of two aquifer pumping tests;
- Test pit excavations;
- Subsurface soil sampling and analysis;
- Surficial soil sampling and analysis;
- Leachate samples and analysis;
- Surface water and sediment sampling and analysis;
- Groundwater sampling and analysis;
- Preliminary ecological assessment; and
- Geotechnical laboratory soils analysis.

The results of the RI, presented in the *Remedial Investigation Report* (ESE, 1994), were used to develop a conceptual model for the Parker Landfill Project as summarized in the following section.

1.3 CONCEPTUAL MODEL

Based upon the results of the investigations, a conceptual model of the Study Area has been developed. This model, which is summarized in the following subsections, forms the basis for the evaluation of remedial alternatives for the Study Area. To aid in understanding the following verbal presentation of the Conceptual Model, geologic cross sections which illustrate the fill depth of each source area, water table elevation, thickness of various geologic units, estimated hydraulic conductivities of those units, locations of existing monitoring wells, and screen depths are presented as Plates A through G.

1.3.1 Surficial Geology

Four major overburden deposits are of importance in the Study Area: Proximal glacial-lacustrine deposits (Proximal units), Distal glacial-lacustrine deposits (Distal units), an esker deposit and an esker-delta deposit. These overburden deposits are approximately 250 feet thick along the Passumpsic River, and 100 to 150 feet thick under the SWDA and IWS 1 and IWS

2 Areas. Along the eastern side of the Study Area, the overburden deposits pinch out against the steeply rising bedrock. The overburden units are each described as follows:

- The Proximal unit consists of medium-to-fine sand and silty, fine sand with occasional layers of coarse to medium sand. Visible soil layers within these deposits dip toward the southeast. The Proximal unit is extensive throughout the Study Area. At the far western edge of the Study Area, it is bounded by the north-south trending esker deposit. The Proximal unit is bounded on the east by the bedrock highlands. Under the northern two-thirds of the Study Area, the Proximal unit is split into an Upper Proximal unit and a Lower Proximal unit by the Distal unit (described below).

- The Distal unit consists of thinly interbedded to thinly interlaminated very fine sand, silt, and clay. The Distal strata are varved at some test boring locations. The Distal unit is approximately 85 feet thick immediately beneath the SWDA and decreases in thickness radially from the SWDA.

- The esker delta deposit consists of cross-bedded coarse-to-fine sand and gravel that grades northeasterly and easterly into predominantly fine sand, which is indistinguishable from the Proximal unit. The west-to-east trending esker delta deposit apparently disrupts the Distal unit immediately south of the SWDA and IWS Areas.

- An esker is located just beyond the western limit of the Study Area. The esker deposits consist of coarse-to-medium sand, gravel, and imbricated cobbles in graded and cross-bedded, imbricated channel deposits, bounded by cross-bedded, coarse-to-medium sand.

1.3.2 Bedrock Geology

Based upon the published reports of Dennis (1956) and Woodland (1965), the Study Area is underlain by the Waits River and Gile Mountain Formations. The Waits River Formation consists of a quartzose-limestone/phyllitic-limestone member and an amphibolite member. The Gile Mountain Formation consists of a quartzose phyllite. RI data indicate the possible presence of a broad (700 to 800 foot-wide) northeast-southwest trending zone of fractured siliceous-phyllitic bedrock along the eastern margin of the SWDA. This zone generally corresponds with the published location of the gradational contact between the Waits River and Gile Mountain formations and extends from IWS 3 southwesterly towards the Riverside School Area.

The upper five to 10 feet of bedrock is generally highly weathered and constitutes a regolith layer, particularly in the vicinity of, and east of, the SWDA.

1.3.3 Hydrogeology

As detailed in the RI, the hydrogeology of the Study Area is comprised of three primary hydrogeologic units: the Upper Proximal unit, the Lower Proximal unit, and fractured bedrock. Over most of the Study Area the Lower Proximal and fractured bedrock flow zones are separated from the Upper Proximal zone by the Distal unit, which is a semi-confining unit. The transmissivity of the Lower Proximal unit is approximately two orders of magnitude greater than the transmissivity of the fractured bedrock, and the Upper Proximal is very limited in areal extent. The saturated portion of the Upper Proximal is completely contained within the Study Area and is not used for water supply. Although private wells are installed in both the fractured bedrock and the Lower Proximal, although residences in the vicinity of the landfill are either connected to, or have access to the municipal water supply. Therefore, in terms of groundwater flow rate, the Lower Proximal zone is the principal water-bearing unit in the Study Area. The three primary hydrogeologic units are described below.

Upper Proximal

The saturated Upper Proximal hydrogeologic unit is present only in the northeastern portion of the Study Area. The saturated thickness of this unconfined unit is up to 30 feet. Groundwater enters the Upper Proximal unit as recharge from precipitation, seepage from the Unnamed Stream, and unsaturated flow at the top of the Distal unit. Groundwater leaves the Upper Proximal as discharge to the Unnamed Stream, as evapotranspiration in the wetlands, and as underflow at the southwest boundary of this unit (IWS 2 Area). In this area, groundwater underflow from the Upper Proximal enters the Lower Proximal unit through a breach in the Distal unit (the Esker Delta Deposit). A piezometric head differential of up to 25 feet is observed between the Upper Proximal unit and the Lower Proximal unit at this location.

The hydraulic conductivity, or capacity of a soil unit to transmit water (see Explanation of Hydrogeologic Terms in Appendix F), of the Upper Proximal, as estimated using slug tests, ranges from 0.1 ft/day to 100 ft/day. The hydraulic conductivity in this unit averages seven ft/day, and appears to increase toward the southwest. Groundwater flow in the Upper Proximal converges from the northwest and northeast toward the center of the unit. The net groundwater flow direction, and observed flow direction in the southwest third of the unit, is toward the southwest.

Lower Proximal

The Lower Proximal hydrogeologic unit (Lower Proximal) includes the saturated portions of the Lower Proximal soils unit, the saturated portion of the Esker Delta soils unit, and the limited regolith (weathered bedrock) unit. The Lower Proximal unit extends across the entire Study Area except under the SWDA, where it may be pinched out by the Distal unit. The saturated thickness of the Lower Proximal ranges from zero feet at the bedrock valley wall to over 125 feet in the southwest corner of the Study Area. Within the SWDA and IWS Areas, the saturated thickness ranges from zero to approximately 90 feet.

The Lower Proximal is generally unconfined except in the northwest portion of the Study Area, including the SWDA, where the Distal unit acts as a semi-confining layer. Precipitation recharges the Lower Proximal where the Distal unit is breached by the Esker Delta and in the southern third of the Study Area, where the Distal unit is missing. The Lower Proximal is also recharged by leakage from the Distal unit, losing reaches of the Unnamed Stream, and groundwater underflow. Groundwater leaves the Lower Proximal as discharge to the Passumpsic River, and as groundwater underflow to the regional groundwater system.

The hydraulic conductivity of the Lower Proximal, as calculated from slug tests, ranges from 0.2 ft/day to 70 ft/day. The transmissivity of this unit (the rate at which water is transmitted through a unit width of an aquifer), as determined by a pumping test conducted in the IWS 2 Area, is 5,400 ft^2/day. The specific yield (ratio of drainable water to the volume of soil) calculated from the pump test, was 0.04.

On the eastern side of the Study Area, where the hydraulic conductivity is low, the Lower Proximal is thin and runoff from the valley wall is high, the hydraulic gradient (change in water table elevation over a unit distance) is in the range of 0.05 to 0.09. Groundwater flow in this area is to the west-northwest. Under the SWDA, the hydraulic gradient decreases rapidly and groundwater flow turns toward the southwest as the hydraulic conductivity and saturated thickness increase. Hydraulic gradients in the Lower Proximal between the SWDA and the Passumpsic River are in the range of 0.001 to 0.002.

Fractured Bedrock

Bedrock underlies the Lower Proximal and Distal units across the entire Study Area. In general, the bedrock hydraulic conductivity is too low to transmit significant volumes of water and bedrock acts as a lower confining layer. However, as previously described, a 700 to 800 foot wide zone of fractured bedrock apparently extends through the IWS 3 Area toward the Riverside School area. Higher hydraulic conductivities within the fracture zone allow the movement of groundwater.

The northeast portion zone of fractured bedrock, in the area of IWS 3, is semi-confined by the Distal unit, which lies directly above bedrock in this area. Over the remainder of the Study Area, the fractured bedrock is overlain by the Lower Proximal. Groundwater enters the fractured bedrock as groundwater underflow through bedrock and from the Lower Proximal. Groundwater exits the fractured bedrock as groundwater underflow through bedrock and possibly into the Lower Proximal.

The hydraulic conductivity of the unfractured bedrock, as measured in packer tests, is on the order of 0.03 ft/day. The transmissivity of the fractured bedrock, as measured by a pumping test conducted in the IWS 2 Area, is 45 ft^2/day. Assuming a thickness of 50 feet, the hydraulic conductivity of the fractured bedrock is calculated to be on the order of 0.8 ft/day, or approximately two orders of magnitude greater than the unfractured bedrock. Based upon the cone of depression (depression of the water table around a pumping well) observed during the pump test, the fractured bedrock appears to be strongly anisotropic (the cone of depression is not circular, but elongated along a zone of higher hydraulic conductivity), with the major hydraulic conductivity axis three times greater than the minor hydraulic conductivity axis and oriented parallel to the fracture zone.

The hydraulic gradient in the fractured bedrock, as measured in the IWS 2 Area, is on the order of 0.09. The direction of decreasing hydraulic gradient is west to west-northwest. Because of the southwest orientation of the zone of fractured bedrock and anisotropy axis, the groundwater flow is not perpendicular to the hydraulic gradient contours, but is more toward the southwest, following the fracture zone.

1.3.4 Contaminants of Concern

Contaminants of Concern for the Parker Landfill are presented in Table 1-1.

1.3.5 Nature and Extent of Contamination

1.3.5.1 Potential Source Areas and Groundwater Impacts

Four potential source areas within the Parker Landfill were identified during the RI: the SWDA, IWS 1, IWS 2, and IWS 3. Physical descriptions of these areas were included in Section 1.2.2. The following summary further describes these areas with respect to their potential impacts on groundwater, based on laboratory analyses and the hydrogeologic model of the Study Area.

<u>SWDA</u>

Based on analyses of surface and subsurface soil samples and leachate samples from along the perimeter of the SWDA, waste materials in the SWDA are considered the source of leachate which contains, among other constituents, ketones (acetone, 2-butanone, 2-hexanone, 4-methyl phenol, benzoic acid, and phenol), and various metals. Precipitation percolates through the waste mass across the entire SWDA. Leachate is generated throughout the SWDA and delivered to the groundwater at varying concentrations across the SWDA. Therefore, individual source areas within the SWDA cannot be identified and the whole SWDA is considered to be a diffuse source.

Leachate samples were collected from three leachate flows along the eastern perimeter of the SWDA and analyzed for TCL-VOC, TCL-A/BN and TCL-Pesticides/PCB, and TAL-Metals.

- No pesticides or PCB were detected in any of the samples;

- Low levels of benzoic acid, phenolic compounds, and naphthalene were detected. No other acid/base neutral compounds were detected above the CRQL in any of the samples;

- VOC (ketones, ethyl benzene, toluene, and xylenes) were detected at all three sample locations.

- Metals were detected above and below background concentrations. Background concentrations were determined from analyses of groundwater at monitoring well G101B. Arsenic and copper were detected in leachate samples, but not in the background well. One replicate sample is significantly higher in all metals. This is potentially due to increased sediment in the replicate sample. Except for this sample, results for samples are generally within three times background concentrations;

- No direct correlation is apparent between the compounds measured in the leachate samples and those measured in associated surface soil samples. Significantly fewer organics were detected in surface soil samples, as compared to the leachates.

Plate H shows groundwater concentrations across the Study Area. The concentration values are the maximum concentrations measured in any groundwater sampling round. Concentrations are provided for TCE, DCE, total other chlorinated VOC and total non-chlorinated VOC. Compounds originating in the SWDA may enter the Lower Proximal where the Distal is thin or missing (at the eastern side of the SWDA, in the IWS 2 Area, and, if they exist, possibly through holes in the Distal beneath the SWDA). Migration is then to the west, southwest and south-southwest toward the Passumpsic River. Because of the complex nature of the geology in this area, and the convergence of migration pathways, separate plumes from the IWS Areas and SWDA cannot be distinguished.

Total VOC concentrations (primarily non-chlorinated VOC), in shallow groundwater (Upper Proximal) near the SWDA ranged from approximately 2.1 mg/l (G115A) to approximately 5.7 mg/l (G114A). Total VOC concentrations in shallow wells (Upper Proximal bridge wells) near the downgradient edge of the SWDA ranged from non-detect (G138A, G136A) to approximately 3.9 m/gl (G109A). Total VOC concentrations in deeper wells (TOR/Lower Proximal) at the downgradient edge of the SWDA ranged from approximately 0.02 mg/l (G110B) to 6.4 mg/l (G109C). Total VOC concentrations in overburden wells located approximately 1,000 feet from the SWDA and IWS Areas are in the range of non-detect (G120A, a bridge well) to 0.1 mg/l (B119B, a bridge well).

Compounds originating in the SWDA may also enter fractured bedrock via the Lower Proximal unit or via direct movement into bedrock and migrate along the fractured bedrock zone to the southwest. Total VOC concentrations at the top of rock (Distal/Lower Proximal) on the east side of the SWDA ranged from approximately 0.09 mg/l (G114B) to 0.27 mg/l (G115B).

IWS 1

Soil samples from the IWS 1 Area and underlying Distal unit contained chlorinated VOC, petroleum-related VOC, polynuclear aromatic hydrocarbons (PAH) and metals above and below background levels.

The relatively low permeability and fine grain size composition of the Distal unit is interpreted to result in slow vertical and horizontal migration of contaminants and significant contaminant attenuation due to adsorption to the soil matrix. The deepest detection of Contaminants of Concern in soil beneath IWS 1 was well above the water table, (the water table is approximately 85 feet below the bottom of the IWS 1 waste mass) indicating that contaminants may have migrated laterally within the unsaturated zone to groundwater.

VOC originating in the IWS 1 Area apparently migrate easterly within the Upper Proximal hydrogeologic unit, along the top of the Distal unit, then enter the Lower Proximal through a window or hole in the Distal or at the eastern edge of the SWDA. As shown on Plate H, chlorinated VOC were detected at the eastern edge of the SWDA at total concentrations ranging from 0.01 mg/l (G115B a TOR well) to 0.24 mg/l (G114A a bridge well). Migration is then in a south-westerly direction towards the Passumpsic River. As previously stated, separate plumes from the IWS 1 Area and SWDA cannot be distinguished. Total VOC concentrations detected within the combined SWDA/IWS Area plume are shown on Plate H and were described previously.

<u>IWS 2</u>

The majority of soil contamination at IWS 2 is associated with three distinct disposal locations. The analytical data indicate the presence of chlorinated VOC and of petroleum related VOC (benzene, toluene, and xylene) at levels that are generally higher than in the other IWS Areas. The waste material is located above the water table. Contaminants of Concern were also detected in underlying soils, however concentrations decrease significantly below the water table. Metals were detected above and below background concentrations in IWS 2.

By comparing the analytical data, specifically the non-chlorinated VOC concentrations with chlorinated VOC concentrations shown on bar graphs on Plate H, the IWS 2 Area does not appear to be a major source of chlorinated VOC in groundwater. Chlorinated VOC concentrations detected in shallow groundwater in the IWS 2 Area range from approximately 0.02 mg/l (G108A) to approximately 0.13 mg/l (GMW13), or 1 order of magnitude less than chlorinated VOC concentrations in shallow groundwater in the vicinity of IWS 1 and IWS 3.

An exception is GERT1, with chlorinated VOC concentrations of approximately 76.6 mg/l. It is believed that this well is encountered in a localized area of residual organic compounds.

Although chlorinated VOC are found in the soils in IWS 2, fine-grained surficial soils and fairly rapid runoff appear to limit the volume of water flushing through these soils. By comparing the concentration of chlorinated VOC in the uppermost monitoring wells, (an indication of contaminant concentrations leaching into groundwater from IWS 2) with chlorinated VOC concentrations in the deeper monitoring wells, (an indication of contaminant concentrations migrating through the subsurface from other sources) it appears that most of the chlorinated VOC found in the groundwater in the vicinity of IWS 2 may have originated in the IWS 3 Area. Groundwater from the IWS 3 Area (Upper Proximal) enters the Lower Proximal in the IWS 2 Area by way of the Esker Delta deposit. The Esker Delta Deposit, considered hydraulically as part of the Lower Proximal, provides a hydraulic connection between the Upper Proximal and the Lower Proximal. The maximum concentrations of chlorinated VOC in the Upper Proximal are in the range of 9.06 to 11.43 mg/l (see IWS 3 discussion). The concentrations of chlorinated VOC in monitoring wells screened in the intermediate and lower parts of the Lower Proximal range from approximately 0.52 mg/l in G108B (TOR) to approximately 1.22 mg/l (G105 TOR).

Non-chlorinated VOC concentrations in IWS 2 range from nondetect in G106A, a bridging well, to 18.30 mg/l in G106B, a TOR well. A combined non-chlorinated VOC compound concentration of 18.80 mg/l was also found in GERT1. As previously stated, it is believed that this well encountered a localized area of residual organic compounds.

Groundwater migration from the vicinity of IWS 2 is to the southwest and south-southwest within the Lower Proximal unit, and possibly into the bedrock and to the southwest along the apparent bedrock fracture zone. Total VOC concentrations in the downgradient overburden wells (Lower Proximal) closest to IWS 2 ranged from nondetect in G136A, a bridge well, to approximately 0.61 mg/l (G136B, a TOR well). As mentioned previously, total VOC concentrations in overburden wells located approximately 1,000 feet from the SWDA and IWS Areas are in the range of non-detect in G120A, a bridge well, to 0.10 mg/l in B119B, a bridge well.

IWS 3

Waste materials within IWS 3 are limited to three distinct waste disposal locations. Soil from test pits excavated at IWS 3 indicate that chlorinated VOC are present at levels generally lower than the levels in IWS 2, and are primarily in the soil beneath the waste. The highest VOC concentrations are in the upper 15 feet, with a significant reduction in VOC between 15 feet and 50 feet. Metals were detected above and below background concentrations in IWS 3. In the IWS 3 Area the water table is approximately 46 feet below the ground surface.

As previously discussed, the Upper Proximal unit is a groundwater transport pathway from the IWS 3 Area. As shown on Plate H, total VOC concentrations in the Upper Proximal, downgradient of IWS 3, range from approximately 9.06 mg/l (G139A BRIDGE/TOD) to approximately 11.43 mg/l (G133). As described above, total VOC are believed to have entered the Upper Proximal west and southwest of IWS 3, and migrated to and entered the Lower Proximal in the vicinity of IWS 2. These compounds apparently may also have entered the Lower Proximal (the regolith soils unit) near or under IWS 3, as evidenced by the total chlorinated VOC concentrations of 5.51 mg/l observed in G132 TOR, (screened in regolith at the top of bedrock). Migration is to the southwest and south-southwest, toward the Passumpsic River within the Lower Proximal unit and possibly to the southwest within the apparent fractured bedrock zone. However, a separate plume of groundwater containing Contaminants of Concern from the IWS 3 Area cannot be delineated due to the complex nature of the geology in this area and the convergence of migration pathways. Total VOC concentrations in the downgradient overburden wells (Lower Proximal) closest to IWS 2 ranged from approximately 0.44 mg/l (GMW4A, a bridge well) to approximately 0.61 mg/l (G136B, a TOR well). VOC concentrations in overburden wells located approximately 1,000 feet from the SWDA/IWS are in the range of non-detect (G120A, a bridge well) to 0.10 mg/l (B119B, a bridge well).

Potential Saturated Zone Sources

Extensive investigations during the RI defined the physical limits of waste material within IWS 1, 2, and 3. These waste materials lie within the unsaturated zone. Soil containing much lower concentrations of Contaminants of Concern was also detected below the waste material in IWS 2 and 3. Some of these detections were in the saturated zone.

Although saturated zone detections of Contaminants of Concern were limited in the immediate vicinity of the IWS Areas, it is possible, based on historic disposal practices, that dense nonaqueous phase liquid (DNAPL) is present within the saturated zone. In the subsurface, the undissolved phase of dense liquids can migrate vertically and laterally following pathways that are unpredictable because they are influenced by small changes in subsurface stratigraphy (changes in grain size, pore size, and pore pressure). If the DNAPL reaches the water table, it may continue to migrate downward, if it has very low solubility in water and is heavier than water, it sometimes moves in directions contrary to groundwater flow. As it migrates through the subsurface, DNAPL residual is left in pore spaces along the migration pathway, and pools may form above finer grained strata or where there are changes in pore pressure that are sufficient to prevent further downward migration.

DNAPL migrates and reaches a stable configuration relatively quickly, and will not migrate further unless disturbed. Although chlorinated solvents have a low solubility in water, the solubility is significantly higher than the drinking water limits for these compounds. Therefore, residual DNAPL and DNAPL pools, if any exist in the saturated zone, can serve as a long-term source of dissolved constituents to groundwater above drinking water standards.

The location of DNAPL as residual or pools, if present in the subsurface, is difficult or impossible to determine. This is because the migration pathways are highly unpredictable, and the DNAPL may migrate laterally a significant distance from the original release location. It is difficult to detect the presence of DNAPL, even when drilling directly through it. Extreme caution must be taken in investigations and excavations in potential DNAPL zones, because disturbance of DNAPL pools may mobilize otherwise stable accumulations, and increase the extent of contamination.

Although there is no direct evidence that DNAPL is present within the saturated zone, its' potential presence must be acknowledged because of the impact this may have on the effectiveness of remedial measures. For example, remedial measures within the IWS Areas could effectively address waste materials within these areas; however, DNAPL sources within the saturated zone outside of the physical limits of the IWS Areas, if present, would continue to impact groundwater. Because the total mass of Contaminants of Concern that may be present in the saturated zone cannot be reliably determined, the degree to which groundwater quality may improve and timeframe for reduction of constituent levels to drinking water standards cannot be calculated.

1.4 HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENTS

1.4.1 Human Health Risk Assessment

A risk assessment was conducted by TRC Environmental Corporation (TRC) on behalf of EPA (EPA, 1992) to evaluate the impact of constituents associated with the Parker Landfill on human health and the local ecology. The human health risk assessment was a quantitative evaluation of both the carcinogenic and the non-carcinogenic effects of selected Contaminants of Concern. The assessment assumed normal human usage and activity patterns ($\geq 75^{th}$ percentile) in the evaluation of the exposure of:

- both children and adults to groundwater (ingestion, inhalation of fugitive VOC);
- surface and subsurface soils (ingestion, dermal contact);
- surface water (dermal contact);
- stream sediment (ingestion, dermal contact); and
- air (inhalation).

In addition to the above, the maximum concentration (i.e., the 100^{th} percentile value) was used to calculate the upper end of both the carcinogenic and non-carcinogenic risk. Table 1-2 and 1-3 summarizes the Contaminants of Concern in various media for both carcinogenic risk and non-carcinogenic hazard, respectively. Tables 1-4 and 1-5 present a complete summary of the risk assessment parameters for both carcinogenic and non-carcinogenic effects, including media source, location, receptor type, exposure pathway, time frame, and risk or hazard endpoints.

The risk assessment concludes that consumption of on-site groundwater presents the majority of the potential health hazard. Both the carcinogenic risk (3×10^{-4} to 2×10^{-2}) and the non-carcinogenic hazard index (6 to 500) exceeded EPA guidelines for acceptable risk or hazard ($\geq 10^{-4}$ and 1.0, respectively). Most of the risk or hazard was found to be attributable to trichloroethene, vinyl chloride, tetrachloroethene, arsenic, and beryllium. Ingestion of sediment also presented an unacceptable incremental cancer risk (4×10^{-4}) for the maximum exposed individual. For non-carcinogenic effects, ingestion presented an unacceptable hazard for the maximum exposed individual child for sediment and adult for surface/subsurface soil.

Off-site concentrations of these chemicals in groundwater were lower. The risk, therefore, to residential groundwater consumption was much lower (8×10^{-6} to 3×10^{-5}). Risk estimates and hazard indices for other exposure pathways generally fell within acceptable limits.

1.4.2 Ecological Risk Assessment

The ecological risk was also evaluated by TRC on behalf of EPA (EPA, 1992). Both qualitative and quantitative evaluations were conducted and generally focused on the wetlands and IWS Areas that are adjacent to and downstream of the SWDA (the wetlands ultimately discharge to the Passumpsic River via the Unnamed Stream). Impacts to the stream(s) were assessed by 1) comparison of surface water concentrations to USEPA ambient water quality criteria (AWQC), and 2) collection of macroinvertebrates following the upstream and downstream placement of artificial substrates (rock baskets). Although several metals exceeded the AWQC hazard indices, field sampling of macroinvertebrates showed little, if any, impact related to the Parker Landfill. Iron was highlighted as having significant impacts in both surface water and sediment.

Terrestrial impacts were evaluated by assessing exposure and the toxicity of various Contaminants of Concern in soil (following ingestion) to the meadow vole, the short-tailed shrew, and the fox. A stochastic model, similar to methodology used for human health risk assessment, was used to evaluate toxic endpoints. Aluminum, cadmium, iron, barium, and cobalt were highlighted as a concern within the IWS Areas, although the ecological risk assessment points out that the degree of uncertainty associated with either the assumptions or the toxicity benchmarks is fairly high.

In general, with the exception of physical impacts caused by siltation due to erosion from existing cover material, the landfill poses no significant adverse effects to ecological receptors in or adjacent to the wetlands. It is therefore anticipated that no remedial action objectives be developed to expressly address improvement of adjacent wetlands and inhabitants therein. Construction of a RCRA cap will encroach on a small segment of wetland. The potential need for wetlands mitigation as a result of this encroachment is addressed in the FS.

1.5 IDENTIFICATION OF RESPONSE AREAS/MEDIA

Based on the data collected during the RI, and the results of the HRA, two response areas have been identified for further evaluation: (1) the SWDA and IWS Areas (1, 2, and 3), and (2) groundwater.

1.5.1 Identification of Remedial Action Objectives

The following specific remedial action objectives have been identified for each response area:

SWDA and IWS Areas

- Minimize, to the extent practicable, the potential for transfer of hazardous substances from the soil and solid waste into the groundwater, surface water, and sediment;
- Prevent direct contact/ingestion of soil or solid waste posing a potential total cancer risk greater than 10^{-4} to 10^{-6}, or a potential hazard index greater than one; and
- Comply with federal and state ARARs.

Groundwater

- Prevent ingestion of groundwater containing Contaminants of Concern in excess of federal or state standards, or posing a potential total cancer risk greater than 10^{-4} to 10^{-6}, or a potential hazard index greater than one;
- Comply with federal and state ARARs.

1.5.2 Institutional Objectives

Section 121 of CERCLA requires, in part, that if any hazardous substances will remain on-site at the conclusion of a remedial action, the level or standard of control that must be met for hazardous substances remaining at the Landfill is at least that of any applicable or relevant and appropriate requirement, criteria, or limitation under any Federal environmental law, or any more stringent standard, promulgated pursuant to a state environmental statute. The NCP (40 CFR 300.5; EPA, 1990) defines "applicable" and "relevant and appropriate" as follows:

> <u>Applicable</u>
> "Applicable requirements means those clean-up standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable."
>
> <u>Relevant and Appropriate</u>
> "Relevant and appropriate requirements means those clean-up standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate."

These standards of control are termed "applicable or relevant and appropriate requirements", or ARARs. Determination of ARARs is site-specific and depends on the location of the site, remedial actions under consideration, and chemical contaminants of concern. In order to determine whether a requirement is an ARAR for a particular site, the "applicability" of the requirement must first be analyzed. If the requirement is not "applicable," then the determination must be made whether the requirement is "relevant and appropriate" to the circumstances of the site. An on-site remedial action must comply with all ARARs, unless a waiver can be justified.

In August 1988, EPA issued a guidance document entitled *CERCLA Compliance with Other Laws manual: Interim Final* (EPA/540/G-89/006; EPA, 1988b). This document sets forth the general procedure for selection of ARARs and details ARAR selection under several federal environmental statutes. EPA has identified another category of criteria, advisories, guidance, and proposed regulations that are "to be considered" (TBC) for the purpose of interpreting ARARs, or to determine preliminary remediation goals when ARARs do not specifically address particular contaminants. TBCs are neither promulgated nor enforceable; therefore, compliance with TBCs is not mandatory in the same way as ARARs.

A remedial action selected for a particular site must comply with federal ARARs, and with state ARARs to the extent that they are more stringent than their federal counterparts. CERCLA §121(d) provides for waivers from ARARs under certain circumstances that are detailed in a fact sheet titled *Overview of ARARs-Focus on ARARs Waivers* (EPA, 1989), which is derived from the *CERCLA Compliance with Other Laws Manual: Interim Final.* This manual identifies several other opportunities for waivers from ARARs under site-specific circumstances. The Technical Impracticability waiver may be invoked when compliance with an ARAR is technically impracticable from an engineering standpoint. The waiver may be used if either engineering methods necessary to construct and maintain a remedial alternative cannot reasonably be implemented, or the reliability regarding the potential for the alternative to continue to be protective into the future is low. Use of the waiver may consider cost; however, cost should not be the major factor for invoking the waiver.

CERCLA §121(d) specifies that remedial actions shall attain a standard of clean up that attains Maximum Contaminant Level Goals (MCLGs) promulgated under the Safe Drinking Water Act and/or water quality criteria established under the Clean Water Act. Note that for MCLGs equal to zero, EPA uses the corresponding Maximum Contaminant Levels (MCLs). The statute allows an exception to this general rule by permitting establishment of Alternative Concentration Limits (ACLs) for hazardous constituents under certain circumstances, including:

- points of entry of contaminated groundwater into surface water are known and projected;

- no statistically significant increase of constituents from groundwater in surface water will occur at the point of entry (or downstream); and

- the remedial action includes enforceable measures that will preclude human exposure to the contaminated groundwater at any point between the facility boundary and all known or projected points of entry of groundwater into surface water.

Therefore, in limited situations in which enforceable institutional measures will effectively preclude the use of drinking water in an area, ACLs may be established. The assumed point of human exposure for risk assessment purposes when using ACLs will be the point at which groundwater enters surface water.

The guidance document *Conducting Remedial Investigation/Feasibility Studies for CERCLA Municipal Landfill Sites* (EPA, 1991) divides ARARs into three types: (1) Chemical-specific ARARs; (2) Action-specific ARARs; and (3) Location-specific ARARs. They are defined as follows:

- Chemical-specific ARARs are usually technology- or risk-based numerical limitations or methodologies that, when applied to site-specific conditions, result in the establishment of acceptable concentrations of a chemical that may be found in or discharged to the ambient environment;

- Location-specific ARARs are the restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they occur in special locations. These requirements relate to the geographical or physical position of municipal landfill sites rather than to the nature of the contaminants or the proposed remedial actions; and

- Action-specific ARARs are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous substances. These requirements typically define acceptable treatment, storage, and disposal procedures for hazardous substances during the implementation of the response action.

Chemical-specific ARARs are used to "help determine the remediation goals" (see Section 1.5.3) and location- and action-specific ARARs are considered during the detailed evaluation of the potential remedial alternatives developed for the Study Area. Chemical-, location-, and action-specific ARARs that have been identified for each remedial alternative are discussed in greater detail in the detailed evaluation, presented in Section 4 of the FS.

1.5.3 Development of Remediation Goals

In order to determine where remediation efforts should be focused and the level of remediation necessary, remediation goals are developed. A remediation goal is developed for each Contaminant of Concern that has been detected in groundwater, and is based on ARARs, when available. When there are no ARARs associated with a specific compound and medium, a health risk evaluation is conducted to determine the appropriate remediation goal for potential exposure to the Contaminants of Concern.

1.5.3.1 SWDA and IWS Areas

There are no ARARs for remediation of soils or solid waste. Remediation goals are derived from the remedial objectives stated in Section 1.5.1. For the SWDA and IWS Areas, these are:

- Minimize, to the extent practicable, the potential for transfer of hazardous substances from the soil and solid waste into the groundwater, surface water, and sediment,
- Prevent direct contact/ingestion of soil or solid waste present within the SWDA and IWS Areas posing a potential total cancer risk greater than 10^{-4} to 10^{-6}, or a potential hazard index greater than one; and
- Comply with federal and state ARARs.

The remedial objectives for the SWDA and IWS Areas are addressed by the caps which will be placed over these areas as the presumptive remedy (see Section 1.6). The caps will prevent direct contact with soil or solid waste within the SWDA and IWS Areas, and will minimize the potential for transfer of Contaminants of Concern from the unsaturated zone to groundwater through infiltration. Due to the presumptive remedy, remediation goals calculated based on exposure risk and leaching potential would only be relevant to the No Action Alternative. Therefore, remediation goals for soil in the SWDA and IWS Areas are not developed.

Groundwater remediation goals are based on ARARs or risk-related criteria as well as the remedial action objectives, which are to:

- Prevent ingestion of contaminated groundwater containing Contaminants of Concern in excess of federal or state standards, or posing a potential total cancer risk greater than 10^{-4} to 10^{-6}, or a potential hazard index greater than one; and
- Comply with federal and state ARARs.

Federal drinking-water and Vermont Enforcement Standards (VES) for Contaminants of Concern are shown in Table 1-1. The analytical data generally suggest that the presence of the non-chlorinated VOC, detected in the overburden above MCLs, is not widespread downgradient of the Parker Landfill.

1.6 PRESUMPTIVE REMEDY

Under its SACM, EPA has established the concept of presumptive remedy as a mechanism to streamline site studies and clean up actions, thereby, improving consistency, reducing costs, and increasing the pace at which Superfund Sites are remediated. The objective of the presumptive remedies approach is to use clean up techniques shown to be effective in the past, at similar sites in the future. Presumptive remedies are expected to be used at all appropriate sites except under unusual circumstances (EPA, 1993b).

One such application of the presumptive remedy approach is at municipal landfill sites, such as the Parker Landfill. EPA's Directive *Presumptive Remedy for CERCLA Municipal Landfill Sites*

(EPA, 1993b) establishes containment as the presumptive remedy for CERCLA municipal landfills. EPA recognizes that "waste in CERCLA landfills usually is present in large volumes and is a heterogeneous mixture of municipal waste frequently co-disposed with industrial and/or hazardous waste" (EPA, 1993b). Data derived during the RI and obtained by EPA, indicate that the Parker Landfill consists of the SWDA, which accepted principally municipal waste with some co-disposed industrial waste, and IWS Areas 1, 2, and 3 which accepted principally industrial wastes. Because there may be a potential human health risk associated with direct contact with subsurface soil and waste debris in the IWS Areas and because the SWDA, as a municipal landfill, must be closed with a cap, EPA has supported the concept of capping as the presumptive remedy for the Parker Landfill. Therefore, this FS focuses primarily on evaluating whether measures in addition to capping (i.e., groundwater control and potential hot spot remediation) may be appropriate.

As stated in EPA's *Guidance for Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites* (EPA, 1991), "hot spots that are appropriate for excavation and removal should be in *discrete, accessible locations of a landfill* where a waste type or mixture of wastes *presents a principal threat to human health or the environment*. The area should be large enough so that remediation will *significantly reduce the risk posed by the overall site* and small enough to be reasonably practicable for removal and/or treatment" (emphasis added). Based on preliminary information, it was originally believed that the IWS Areas could conceivably be clearly-definable "hot spots", and that if the materials within one or more of these areas were remediated (depending upon the potential risk and relative significance as a source area), it could potentially remove a principal threat to human health and the environment, and have a significant impact on the remediation time frame.

To evaluate the potential significance of each IWS Area as a "hot spot", the relative amounts of Contaminants of Concern in IWS 1, IWS 2, and IWS 3, presented on the basis of mass (in kg), were calculated. All soil data from the IWS Areas, including samples of waste material (disturbed fill material) and samples of natural soil deposits, collected adjacent to the waste material were used to derive the average concentrations. The results of this analysis are presented as pie charts in Figures 1-2, 1-3, and 1-4 (see Appendix A for details regarding the evaluation procedures) for VOCs, metals, and SVOCs, respectively. Care must be used in the interpretation of these pie charts because they represent the average concentration of each constituent multiplied by the estimated total volume of each waste area. Because the respective proportions of IWS 1, IWS 2, and IWS 3 differ by a factor of 5, 2, and 1, the total mass of IWS 1 will always be larger given similar concentrations of contaminants in soil. The values presented in these figures were derived by multiplying the average (arithmetic) subsurface soil concentrations (mg/kg) (both unsaturated and saturated) by the total mass of each waste area (kg).[1] Furthermore, these percentages are based on the total mass estimated to be present in waste materials within the IWS Areas only, and do not represent the proportion of Contaminants of Concern present in each IWS Area relative to the Study Area as a whole. For example, if additional source materials exist within the saturated zone as DNAPL or within the SWDA, the contaminant mass present within the physical limits of each of the IWS Areas would represent a smaller percentage of the contaminant mass present within the entire area encompassing the SWDA and IWS Areas than that depicted on the pie charts.

Figure 1-2 presents the relative mass VOC compounds in IWS 1, IWS 2 and IWS 3. Using this analysis, it can be seen that IWS 3 contains only 7% of the total VOC mass, 7% of the TCE mass and 2% of the 1,2-DCE mass within the IWS Areas. IWS 1 contains only 7% of the total VOC, 4% of the TCE mass, 7% of the PCE mass, and 2% of the 1,2-DCE mass within the IWS Areas. Figure 1.3 presents the relative mass PAH and PAH compounds in IWS 1, IWS 2, and IWS 3. Note in the table below the PAH figure that the mean concentrations are similar. The relative mass percentage of constituents in IWS 1 are highly skewed as only two samples in IWS 1 had elevated concentrations of SVOC compounds. A similar result was seen for the relative mass percentages for inorganics (Figure 1-4) within the three waste areas. The mass percentages were similar with IWS 1 accounting for the majority of the mass, as this waste area has the largest volume. From the viewpoint of risk to human health, however, inorganics, PAH and SVOC do not present significant adverse effects.

[1] The total mass of each waste area (kg, see RI, Volume 1 of 9, Section 3.5. All samples categorized as "soils" were used on the database, including both "disturbed" fill and natural soil matrix.) was derived by multiplying the volume (cu. yds.) by the appropriate conversion factors (1.5 tons/cu. yd. x 2,000 lb/ton x 0.454 kg/lb).

Removal of the relatively small proportions of the VOC mass present within IWS 1 and IWS 3 would not significantly reduce the risk posed by the Landfill, especially since the materials within these areas will be effectively contained by the presumptive remedy (capping). The caps will prevent direct contact with IWS 1 and 3 area materials and prevent infiltration and leaching of contaminants from these materials to groundwater. Because these areas are not large enough that their removal would significantly reduce the threat posed by the Landfill, IWS 1 and IWS 3 hot spots are not appropriate for potential removal and treatment or disposal, and only capping is considered for these areas in the FS.

As shown on Figure 1-2, IWS 2 contains the greatest mass of "total" VOC. According to this analysis, 87% of the "total" VOC mass, 90% of the TCE mass, 68% of the PCE mass and 89% of the 1,2-DCE mass are located in IWS 2. It should be noted, however, that although IWS 2 contains the greatest mass of "total" VOC, the concentrations of Contaminants of Concern in IWS 2 Area groundwater are 1.5 to 2 orders of magnitude lower than observed in the other IWS Areas, and IWS 2, therefore, does not appear to be a significant source of groundwater contamination. These data indicate that it is unlikely that remediation of IWS 2 would significantly reduce the risk posed by the Landfill, but the potential benefits and adverse impacts of removal and treatment or disposal of IWS 2 materials are evaluated in the FS.

1.7 DOCUMENT ORGANIZATION

The FS document is presented in six sections, each meant to build on the previous sections. Section 1 provided an explanation of the FS process, background information including the history and a brief description of the Study Area; a summary of the conceptual model for the Study Area; a summary of the findings of the Human Health and Ecological Risk Assessments; the development of remedial response objectives; and a discussion regarding the use of a presumptive remedy. Section 2 presents the Identification and Preliminary Screening of Remedial Technologies and Process Options, and Section 3 presents the Development and Initial Screening of Remedial Alternatives. Section 4 provides the Detailed Evaluation of Remedial Alternatives and Section 5 presents the Comparative Analysis.

2.0 IDENTIFICATION AND PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

2.1 INTRODUCTION

In this section, potential technologies and process options that may be applicable for remediation of the identified response areas (the SWDA and IWS Areas 1, 2, and 3, and Groundwater) are preliminarily screened. This screening process supports the development of potential remedial alternatives and involves the following sequence of evaluations:

1) General response measures that have the potential to satisfy the remedial objectives presented in Section 1.5 are identified (Section 2.2).

2) Potential technologies and process options associated with each of the general response measures are identified (Section 2.3).

3) The identified technologies and process options are screened on the basis of technical feasibility, and those that are not technically feasible are eliminated from further consideration (Section 2.3).

4) The retained technologies and process options are evaluated based on their potential effectiveness, implementability, and relative costs. Based on this evaluation, a representative process option is selected for each retained technology type in order to simplify the subsequent development and evaluation of alternatives without limiting flexibility during remedial design. The specific process option that will be employed might not be selected until remedial design (Section 2.4).

2.2 IDENTIFICATION OF GENERAL RESPONSE MEASURES

The following summarizes general response measures that may be appropriate for the Study Area:

No Action: A no-action response provides a baseline assessment for comparison with other alternatives that contain greater levels of response. An alternative involving no action may be considered appropriate when the risk associated with a response area is within the acceptable range, or when an alternative response action may cause a greater environmental or health danger than the no-action alternative itself. An evaluation of the no-action response is required by the NCP as part of the FS process.

Management: Management includes implementation and maintenance of controls designed to inhibit or limit access to a response area/media. These may include physical barriers or institutional controls.

Containment: Containment measures include various technologies which contain and/or isolate the Contaminants of Concern. These measures provide isolation and prevent direct exposure to, or migration of, Contaminants of Concern without disturbing or removing the materials in place. Containment measures generally consist of measures which cover, seal, chemically stabilize, or provide an effective barrier around specific areas.

Withdrawal/Collection: Collection of contaminated groundwater may be achieved via withdrawal techniques such as pumping or gravity drainage. Water treatment may be required in conjunction with groundwater withdrawal/collection actions to reduce constituent levels in the extracted water, thereby allowing its discharge. Treatment techniques may include chemical, biological, or physical systems for separation, concentration, or destruction. Discharge of the treated water could include discharge to a surface water body or Publicly-Owned Treatment Works (POTW) or reinjection.

Removal: Removal measures may be undertaken to remove contaminated media such as waste and debris. For specific types of sites, such as municipal landfills, EPA has determined that total excavation is not likely to be appropriate due to landfill characteristics. Excavation is generally limited to hot spots. As stated by EPA, "hot spots that are appropriate for excavation and removal should be in discrete, accessible locations of a landfill where a waste type or mixture presents a principal threat to human health or the environment. The area should be large enough so that remediation will significantly reduce the risk posed by the overall site and small enough to be reasonably practicable for removal and/or treatment..."(EPA, 1991). Implementation of a removal measure requires proper treatment and/or disposal of the removed material, either on-site or at an approved off-site waste disposal facility. Replacement of the impacted media with clean fill may be necessary subsequent to a removal action. Removal measures may be used to effectively eliminate the contaminated media; however, significant short-term exposure hazards may occur during implementation of a removal action.

In-Situ Treatment: In-situ treatment provides an alternative to withdrawal/collection and removal options for the treatment of soil and groundwater. Various technologies may be used to treat the contaminated media in-place. The technologies include (1) immobilization/destruction of the contaminants by high-temperature methods (e.g., vitrification); (2) biological or chemical breakdown of the contaminants; or (3) physical separation of the contaminants from the media (e.g., soil vapor extraction).

The general response measures identified above are potentially applicable for the remediation of the SWDA and IWS Areas, and Groundwater as indicated below.

RESPONSE AREA	GENERAL RESPONSE MEASURE
• SWDA • IWS 1 • IWS 2 • IWS 3	• NO ACTION • MANAGEMENT • CONTAINMENT • IN-SITU TREATMENT-POTENTIAL HOT SPOT (IWS 2 ONLY) • REMOVAL - POTENTIAL HOT SPOT (IWS 2 ONLY)
• GROUNDWATER	• NO ACTION • MANAGEMENT • CONTAINMENT • IN-SITU TREATMENT • WITHDRAWAL/COLLECTION

2.3 IDENTIFICATION AND SCREENING OF POTENTIAL TECHNOLOGIES AND PROCESS OPTIONS

Tables 2-1 and 2-2 present the remedial technologies and process options associated with each of the potential general response measures that have been identified based on their potential to meet the technical objectives. These technologies are first screened on the basis of technical feasibility. Those remedial technologies/process options considered infeasible due to Study Area characteristics are eliminated from further consideration, although the eliminated technologies may be reconsidered at a later date if the understanding of site conditions changes. The retained technologies and process options are then evaluated based on their potential effectiveness, implementability, and relative costs (Section 2.4).

The following discussions summarize the technology screening step, and provide brief descriptions of the response measures/technologies that were determined to be technically feasible and retained for further evaluation for the SWDA and IWS Areas (Section 2.3.1) and Groundwater (Section 2.3.2). These measures will also be described in more detail further along in the FS, if they are retained through subsequent screening steps. Details regarding the response measures/technologies that were eliminated from further consideration are presented in Tables 2-1 and 2-2.

2.3.1 Technology Screening Summary - SWDA and IWS Areas

As presented on Table 2-1, thirty-two response measures/technologies were considered for the SWDA and IWS Areas. These measures/technologies were identified because they had the potential to satisfy one or more of the remedial objectives for the SWDA and IWS Areas. Eighteen of these measures were eliminated because they were determined not to be technically feasible for these areas. As stated in Section 1.6, capping is considered the presumptive remedy for the Parker Landfill. As presented in Section 1, an analysis of the relative significance of the IWS Areas as potential "hot spots" indicates that, in accordance with EPA guidance, only IWS 2 should be considered for soil excavation and removal or treatment. According to EPA's guidance document *Conducting Remedial Investigations/ Feasibility Studies for CERCLA Municipal Landfill Sites*, "hot spots that are appropriate for excavation and removal should be in discrete, accessible locations of a landfill where a waste type or mixture of wastes presents a principal threat to human health or the environment. The area should be large enough so that remediation will significantly reduce the risk posed by the overall site and small enough to be reasonably practicable for removal and/or treatment." (EPA, 1991). Therefore, taking into consideration the presumptive remedy for the site and the analysis of the relative significance of the IWS Areas, the evaluation of removal and treatment measures/technologies focuses on the IWS 2 Area.

The following response measures/technologies were determined to be technically feasible and retained for further evaluation.

No Action

Under No Action, no measures would be taken to address Contaminants of Concern in soils within the SWDA and IWS Areas. This option is retained as a baseline for comparison with other potential measures, as required by the NCP.

Management

Two limited action response measures/technologies were considered and determined to be potentially applicable to the SWDA and IWS Areas: fencing and institutional controls. Fences could be constructed to limit access, and institutional controls (deed restrictions) could be used to limit the future use and activities at these areas. Both measures would reduce the potential for direct contact with, and ingestion of, soils or waste exceeding remediation goals, and would be technically feasible. Limited action, however, would not meet the technical objective of minimizing constituents reaching groundwater.

Containment

Two types of caps were considered for containment. Only composite-barrier caps meeting the Resource Conservation and Recovery Act (RCRA) Subtitle C requirements were determined to be potentially applicable for containment of the SWDA and IWS Areas. As previously stated, available information regarding the SWDA indicates that municipal waste with some quantities of hazardous material was disposed within the SWDA. However, EPA considers RCRA Subtitle C to be an ARAR for the SWDA area and therefore, a Subtitle D cap conforming to the State of Vermont's solid waste closure requirements is not appropriate for this area. The IWS Areas accepted industrial waste and, therefore, caps conforming to RCRA Subtitle C requirements are appropriate for those areas.

This type of cap would be technically feasible, and would reduce the potential for direct contact with soil and waste that may pose a potential health risk. This type of cap would also minimize the potential for constituents from the unsaturated zone beneath the caps reaching the groundwater.

If a cap is constructed on the SWDA and/or IWS Areas it would be necessary to collect and potentially treat combustible gas that may accumulate beneath the caps. Four gas collection methods were considered. Passive gas collection using pipe vents and active gas collection using extraction wells were both determined to be technically feasible. Enclosed ground flares and adsorption/scrubbing were retained for further consideration as treatment methods. Monitoring of combustible gas was also retained.

In-Situ Treatment - IWS 2 only

Seven treatment technologies were considered for in-situ treatment. Effective implementation of any in-situ technique may be problematic due to the heterogeneity of the soils and debris. Only one technique, vacuum extraction, was determined to have the potential to be technically feasible for VOC treatment of IWS 2. Vacuum extraction would only be applicable within unsaturated soils.

Removal

As stated in Section 2.2, EPA does not consider excavation of the entire SWDA debris mass to be practicable due to the large volume of material present. According to EPA's guidance document *Conducting Remedial Investigations/ Feasibility Studies for CERCLA Municipal Landfill Sites*, "hot spots that are appropriate for excavation and removal should be in discrete, accessible locations of a landfill where a waste type or mixture of wastes presents a principal threat to human health or the environment. The area should be large enough so that remediation will significantly reduce the risk posed by the overall site and small enough to be reasonably practicable for removal and/or treatment." (EPA, 1991). As previously stated, an analysis of the mass of Contaminants of Concern present in the three IWS Areas indicates that, in accordance with EPA guidance, only IWS 2 is large enough, in terms of the proportion of Contaminants of Concern present, so that remediation may significantly reduce the risk posed by the overall site. Therefore, only IWS 2 is considered for soil excavation and removal or treatment.

It should be noted that, although excavation of this area would remove a major portion of VOC located within the IWS Areas, groundwater data do not indicate that soil and waste materials within IWS 2 are significantly impacting groundwater. Furthermore, although there were some detections of Contaminants of Concern in saturated natural deposits below IWS 2, waste material within IWS 2 is not in contact with the water table. Therefore, although some direct leaching to groundwater from the saturated zone would continue, capping of this area would effectively eliminate infiltration and leaching of contamination from the waste materials, which are in the unsaturated zone.

Excavation of IWS 2 material was retained for further consideration. Dewatering of IWS 2 to allow excavation within the saturated zone should not be required, since all waste materials are located in the unsaturated zone and only low levels of Contaminants of Concern were detected in the saturated natural deposits underlying IWS 2. However, temporary dewatering was retained as a potentially applicable technology. Three options for disposal of excavated IWS 2 material were considered. Disposal at an off-site RCRA landfill was retained for further consideration.

Ex-Situ Treatment

Eight treatment technologies were evaluated for the excavated material from IWS 2. One treatment technology/process option, commercial off-site incineration, was determined to be technically feasible for excavated material from IWS 2. The volume of waste material within IWS 2 (approximately 2,000 to 3,000 yd^3) is insufficient to warrant on-site treatment technologies.

2.3.2 Technology Screening Summary - Groundwater

The response measures/technologies that were considered for groundwater are presented in Table 2-2. These measures were identified based on their potential to meet the response objectives for groundwater and are evaluated with respect to their technical feasibility. Those not determined to be technically feasible are eliminated from further consideration. As shown on Table 2-2 and summarized briefly below, 13 technologies/process options for groundwater were retained for additional evaluation. These measures will be described in more detail further along in the FS if they are retained through subsequent screening steps. Details regarding technologies/measures that were eliminated from further consideration are presented in Table 2-2.

No Action

Under No Action Groundwater, no remedial measures would be implemented to address Contaminants of Concern in groundwater, although some natural degradation of organic constituents would occur. This option could be easily implemented, and is retained for further consideration.

Limited Action

Two limited actions, institutional controls and monitoring, have been retained as potentially applicable for the groundwater. Institutional controls alone or in conjunction with other measures could be used to prevent the ingestion of groundwater exceeding remediation goals. Groundwater monitoring could be used alone or in conjunction with another groundwater measure to monitor groundwater conditions or the effectiveness of a remedial measure.

Containment/Isolation

Three passive containment technologies to contain horizontal groundwater flow were evaluated. However, bedrock is present at the Study Area at a depth of approximately 100 to 250 feet below ground surface. Due to the inability to construct a vertical barrier to these depths, and the presence of fractures in the bedrock, a fully penetrating barrier would not be effective. A partially penetrating barrier installed upgradient of the SWDA and/or IWS Areas would not effectively alter the groundwater extraction rates. Therefore, vertical subsurface barriers are eliminated from further consideration. Containment via installation of a cap to prevent rainfall infiltration or hydraulic containment of horizontal groundwater flow using extraction wells are technically feasible technologies, and are retained for further consideration (see Section 2.3.1 and the Section 2.3.2 evaluation of groundwater withdrawal/collection technologies).

In-Situ Treatment

Two technologies were considered for the in-situ treatment of groundwater. None were retained for further consideration due to technical infeasibility.

Withdrawal/Collection

Three withdrawal/collection technologies were evaluated - extraction wells, interceptor trenches, and sparge and vent. Extraction wells and interceptor trenches are commonly used to contain or remediate contaminated groundwater. Extraction wells have been used effectively for the containment of groundwater. Groundwater extraction and treatment has proven less effective, however, when used as a remediation technique to reduce contaminant levels in groundwater to remediation goals. This would be especially problematic within the SWDA and IWS Areas, where source material within the saturated zone may continue to contribute dissolved constituents to groundwater. Trench drains are only effective in intercepting contaminated groundwater where the vertical distribution is well known and confined to a relatively shallow and narrow stratum. Due to the thickness of the aquifer (approximately 90 to 120 feet), trench drains would not be feasible. Sparge and vent can be effective for the removal of volatile contaminants from the saturated zone. However, sparge and vent may be difficult to implement in low permeability soils and in the presence of subsurface obstructions, and there is some risk of further spreading of contaminants. Therefore, only extraction wells are retained for further consideration as a groundwater containment technology.

Ex-Situ Treatment

Eleven potential technologies were considered for the treatment of extracted groundwater. Granular activated carbon, air stripping, and powdered activated carbon treatment (PACT) were determined to be technically feasible for the treatment of organic constituents present in the groundwater. Due to the potential for inorganics to adversely impact the VOC removal system, hydroxide/carbonate precipitation, sulfide precipitation, and ion exchange will be retained for further consideration as inorganics pretreatment techniques.

Discharge

Three potential discharge options were evaluated. Discharge to surface water and reinjection were determined to be technically feasible options for the discharge of extracted groundwater.

Surface water discharge would involve either construction of an outfall pipeline to the Passumpsic River or Unnamed Stream.

2.4 EVALUATION OF RETAINED RESPONSE MEASURES/TECHNOLOGIES AND PROCESS OPTIONS

Tables 2-3 and 2-4 evaluate the effectiveness, implementability, and relative cost of the retained response measures/technologies and process options for the SWDA and IWS Areas and Groundwater, respectively. Based on this evaluation, process options are selected to represent each technology type, in order to simplify the subsequent development and evaluation of alternatives without limiting flexibility during design. The specific technology process that will be used during the implementation of the remedial action might not be selected until the remedial design phase (EPA, 1988a).

The following discussion summarizes the evaluation of retained response measures/technologies and process options and presents the process options that will be used to develop remedial alternatives for the Parker Landfill Project.

2.4.1 SWDA and IWS Areas

As presented on Table 2-3 and summarized below, fourteen technologies/process options were considered for the SWDA and IWS Areas. Ten of these were retained as representative technologies/process options for use in the development of remedial alternatives.

No Action

Should no action be taken with respect to the SWDA and IWS Areas, some natural degradation of organic constituents would occur. The potential for the soil to contribute Contaminants of Concern to the groundwater would remain, as well as the potential for direct contact with soil. **No Action is retained as required by the NCP to provide a basis for comparison with other options.**

Management

Fences could be easily constructed and maintained around the SWDA and IWS Areas. They could be effective in restricting access, thereby reducing the potential for direct contact with soil. Therefore, **fencing is retained for use as a component of remedial alternatives.**

Institutional controls (deed restrictions) which limit future use and activities at the SWDA and IWS Areas could effectively minimize the potential for future exposure to Contaminants of Concern and physical hazards. They could be easily implemented, and therefore **institutional controls are retained for further evaluation as a component of remedial alternatives.**

Containment

Composite-barrier (RCRA) caps would effectively minimize direct contact with soil and also reduce infiltration through and movement of constituents from the unsaturated zone to groundwater. Construction of this type of cap utilizes standard construction techniques. Regrading of the SWDA would be necessary to achieve the appropriate slopes and drainage.

Gas collection systems are appropriate for the collection of combustible gas that may accumulate beneath the impermeable caps installed over the SWDA and IWS Areas. Due to the amount of methane gas expected within the SWDA, active gas collection using extraction wells and treatment of the gas would likely be required. Excessive amounts of methane gas generation are not expected in the IWS Areas due to their size and types of waste in these areas. However, active gas collection and treatment is also retained in these areas.

Due to the large areal size of the RCRA cap (greater than 14 acres), a centrally located gas treatment station may be more cost-effective and easily implemented than numerous individual treatment units. Therefore, an active collection system with a centrally located gas flaring station is retained as a component of the SWDA and IWS Area cap in the feasibility study evaluation.

Caps designed to conform with RCRA Subtitle C requirements are retained for the SWDA and IWS Areas. Combustible gas collection via an active system with gas treatment using enclosed ground flares, and gas monitoring are effective and readily implementable techniques and will therefore be retained for further evaluation for the SWDA and IWS Areas.

In-Situ Treatment

Vacuum extraction is the only in-situ treatment technique that was retained for further consideration during the FS. Vacuum extraction is effective at reducing VOC and therefore is potentially applicable in IWS 2. However, due to the presence of buried debris and variable soil conditions in IWS 2, it may be difficult to achieve adequate and/or homogeneous air flow. Differences in flow rates across the material can cause VOC constituents to be eliminated sporadically, both spatially and temporally. Differences in flow rates can also cause a pressure differential to form across the blower resulting in a high operating temperature and associated increased operating costs. Additionally, vacuum extraction would only address VOC, not other Contaminants of Concern, such as PAH compounds and phthalates, that have been detected in IWS 2.

Although there are significant implementability and effectiveness concerns, **vacuum extraction within the physical limits of IWS 2 will be retained for further evaluation as a VOC-reduction measure, because it is the presumptive remedy for CERCLA Sites with VOC in soils (EPA 540-F-93-048) and the NCP and EPA guidance specify that the range of alternatives to be considered includes treatment alternatives, to the extent practicable. EPA presumptive remedy guidance states, however, that vacuum extraction may or may not be appropriate for VOC-contaminated soils, depending on site-specific conditions.**

Removal

Removal of IWS 2 materials would involve the excavation, handling, and transport of hazardous materials and would pose a risk of worker and community exposure during implementation. There is a potential for air emissions during excavation. A comprehensive health and safety program and dust control measures would need to be implemented during excavation and handling activities. Excavation within the saturated zone should not be required; however, if it were performed, dewatering would be required. Depending on the depth of excavation, extraction of large volumes of groundwater may be necessary. The extracted groundwater would require appropriate treatment and disposal. There may be some risk of mobilizing Contaminants of Concern during excavation and worsening the extent of subsurface contamination. Slope stability following excavation may be a concern.

Removal of IWS 2 materials is not likely to significantly improve downgradient groundwater quality, since RI data indicate that IWS 2 is not significantly impacting groundwater quality under current conditions.

Although excavation of IWS materials would be difficult to implement, and there are also effectiveness concerns, **excavation of IWS 2 is retained for further consideration as a potential source-reduction measure.**

Ex-situ treatment of the excavated IWS 2 material at an off-site incineration facility was retained as the representative process option. Incineration effectively reduces VOC and PAH. Most metals would not be reduced, however, and the ash residue would need to be tested. Disposal of this material as a hazardous waste may be required. Sorting and removal of large items may be required prior to incineration. There would be significant health and safety and community concerns during likely long-distance transport of the material.

2.4.2 Groundwater

As presented in Table 2-4 and summarized below, thirteen technologies/process options were considered for groundwater. Seven of these were retained as representative technologies/process options for use in the development of remedial alternatives.

No Action

Under No Action, no measures would be taken to address constituents in the groundwater. Constituents would continue to migrate and Contaminants of Concern above drinking water limits would remain in the Study Area groundwater until reduced by groundwater flushing, dispersion and natural degradation. However, residences within the known area impacted by groundwater contamination either have access to or are currently connected to the Town of Lyndonville's public drinking water supply. **No Action groundwater is retained for further evaluation.**

Management

Institutional controls could be used to prevent the future development of impacted groundwater as a drinking water source. As long as the institutional controls are enforced, ingestion of groundwater containing Contaminants of Concern above remediation goals would be effectively prevented. Therefore, **institutional controls for groundwater are retained for further evaluation.**

Monitoring of groundwater conditions could be an effective method for tracking the migration of Contaminants of Concern in groundwater, ensuring that controls are in place in the impacted area and/or monitoring the effectiveness of other remedial measures. Monitoring would be performed using existing and possibly additional monitoring wells. Well installation and sample collection and analyses could be easily implemented. **Therefore, groundwater monitoring is retained for use as a component of remedial alternatives evaluated in the FS.**

Withdrawal/Collection

Depending on the design of an extraction well system, extraction wells could be used as a groundwater containment technique to prevent the SWDA and IWS Areas from acting as a source of Contaminants of Concern to downgradient groundwater (source control), or prevent further migration of Contaminants of Concern in downgradient groundwater (migration control).

Installation of extraction wells utilizes conventional well installation techniques. **Extraction wells have been retained as the representative process option for extraction of groundwater.**

Ex-Situ Treatment

Air stripping with granular activated carbon (GAC) polishing is commonly used to remove organic constituents from both wastewater and drinking water supplies, and these systems are widely available. With both treatment technologies, the toxicity is not eliminated, but is transferred to another medium that requires disposal. For air stripping, contaminants are discharged to the atmosphere or concentrated in vapor-phase activated carbon. For the GAC polishing, contaminants are concentrated in the spent carbon, which must be disposed of or regenerated. Incineration or regeneration of spent carbon would destroy toxic organics. To prevent potential fouling and meet discharge requirements, pretreatment to remove or reduce metal concentrations would be required prior to air stripping. Dewatering and disposal of residual materials (dewatered sludge) generated during the inorganics pretreatment will be required. **Air stripping with GAC adsorption polishing has been retained as the representative process option for treatment of organic constituents in extracted groundwater. Hydroxide/ carbonate precipitation is retained as the representative process options for inorganics pretreatment.** Utilization of a multi-technology approach would allow optimum sizing of equipment to properly address various components of the extracted groundwater.

Discharge of Extracted Groundwater

Groundwater would be treated to meet surface water discharge requirements. The technical ability to meet requirements for discharge to the Unnamed Stream is uncertain. An outfall pipeline would be required for every surface water discharge option. The outfall pipeline to the Passumpsic River would be approximately one-half mile in length and would involve significant construction costs. Easements would be required. **Discharge to the Passumpsic River is retained as the representative process option for groundwater extracted from the Landfill and downgradient.**

2.5 SUMMARY OF THE PRELIMINARY SCREENING OF TECHNOLOGIES/PROCESS OPTIONS

Figure 2-1 summarizes the remedial technology screening process discussed in Sections 2.2 through 2.4. As shown on this figure, all of the technologies and process options considered had the potential to achieve one or more of the remedial action objectives defined in Section 1.5. Process options that were eliminated from further consideration are shaded. The representative process options selected will be used in Section 3 to develop potential remedial alternatives for the Parker Landfill Project. As mentioned previously, process options not selected as the representative option may be reconsidered during the design phase.

3.0 DEVELOPMENT AND INITIAL SCREENING OF REMEDIAL ALTERNATIVES

In this section, remedial technologies and representative process options remaining after the preliminary screening process are combined to form remedial alternatives (Section 3.1). Then, in order to reduce the number of alternatives undergoing a detailed evaluation, the alternatives developed are initially screened against three criteria: effectiveness, implementability, and cost (Section 3.2). The remaining alternatives are used to develop source control and management of migration alternatives in Section 4, which presents the detailed evaluation of those alternatives.

3.1 DEVELOPMENT OF REMEDIAL ALTERNATIVES

Since media interactions (soil and groundwater) are likely to occur, remedial alternatives have been developed that address both Groundwater and the SWDA and IWS Areas. In assembling remedial alternatives for the initial screening, representative technology process options that constitute a general response action, and one or more general response actions, are combined. The alternatives are designed to: 1) meet the remedial response objectives for groundwater and soil in the SWDA and IWS Areas; and 2) represent a range of treatment and containment combinations. Nine alternatives have been assembled. These alternatives range from No Action (Alternative 1) to Capping of the SWDA and IWS 1 and 3 Areas/Excavation and Off-site Incineration of IWS 2 Materials/Source Control Groundwater Extraction (Alternative 7). One groundwater remedial alternative, Downgradient Groundwater Extraction/Treatment/Discharge (Alternative 8), may be combined with Alternatives 2 through 7.

The remedial alternatives for Groundwater and the SWDA and IWS Areas at the Parker Landfill are:

Alternative 1:	No Action;
Alternative 2:	Containment (SWDA, IWS 1, 2 and 3)/No Source Control Groundwater Extraction;

Alternative 3: Containment (SWDA, IWS 1, 2 and 3)/Source Control Groundwater Extraction;

Alternative 4: Containment (SWDA, IWS 1, 2 and 3)/In-situ Soil Vapor Extraction of IWS 2 Area/No Source Control Groundwater Extraction;

Alternative 5: Containment (SWDA, IWS 1, 2 and 3)/In-situ Soil Vapor Extraction of IWS 2 Area/Source Control Groundwater Extraction;

Alternative 6: Containment (SWDA, IWS 1 and 3)/Excavation and Off-site Incineration of IWS 2 Materials/No Source Control Groundwater Extraction;

Alternative 7: Containment (SWDA, IWS 1 and 3)/Excavation and Off-site Incineration of IWS 2 Materials/Source Control Groundwater Extraction; and

Alternative 8: Downgradient Groundwater Extraction/Treatment/Discharge (may be combined with Alternatives 2 through 7).

Alternative 8A: Downgradient Groundwater Extraction/Combined with Alternatives 2, 4, or 6 (No Source Control Groundwater Extraction System).

Alternative 8B: Downgradient Groundwater Extraction/Combined with Alternatives 3, 5, or 7 (Source Control Groundwater Extraction System).

3.2 INITIAL SCREENING OF REMEDIAL ALTERNATIVES

In order to reduce the number of alternatives undergoing a detailed evaluation, the alternatives developed in Section 3.1 were initially screened against three criteria: effectiveness, implementability, and cost. The significance of these screening criteria, as defined in EPA guidance, is as follows:

Effectiveness: This criterion focuses on the degree to which an alternative reduces toxicity, mobility or volume through treatment; minimizes residual risks and affords long-term protection; complies with ARARs; minimizes short-term impacts; and how quickly it achieves protection. Alternatives providing significantly less effectiveness than other, more promising alternatives may be eliminated. Alternatives that do not provide adequate protection of human health and the environment shall be eliminated from further consideration (EPA, 1990).

Implementability: This criterion focuses on the technical feasibility and availability of the technologies each alternative would employ and the administrative feasibility of implementing the alternative. Alternatives that are technically or administratively infeasible or that would require equipment, specialists, or facilities that are not available within a reasonable period of time may be eliminated from further consideration (EPA, 1990).

Cost: The costs of construction and any long-term costs to operate and maintain the alternatives shall be considered. Costs that are grossly excessive compared to the overall effectiveness of alternatives may be considered as one of several factors used to eliminate alternatives. Alternatives providing effectiveness and implementability similar to that of another alternative by employing a similar method of treatment or engineering control, but at greater cost, may be eliminated (EPA, 1990).

The initial screening for the potential remedial alternatives is presented below. For each alternative, the major components are identified, and an evaluation of the effectiveness, implementability and estimated order-of-magnitude cost are presented. The results of the initial screening of each alternative are also presented along with the justification for the screening decision.

3.2.1 Alternative 1: No Action

Description - Alternative 1

Under Alternative 1, no measures would be implemented to address the soil and groundwater contamination associated with the Parker Landfill. A five-year site review would be conducted to review the potential health and environmental impacts associated with the site and evaluate chemical degradation within the aquifer expected to occur due to natural processes.

Effectiveness - Alternative 1

Alternative 1 does not include measures that would minimize or eliminate the potential for contact with soil containing Contaminants of Concern. A reduction in toxicity, mobility, and volume (TMV) of Contaminants of Concern through treatment would not occur; however, some reduction in the concentrations and mass of Contaminants of Concern would occur through groundwater flushing, dispersion, and natural degradation processes. The timeframe for natural attenuation to drinking water standards is not predictable within the foreseeable future, because the total mass of Contaminants of Concern in the SWDA and IWS Areas cannot be accurately determined. Although Contaminants of Concern would continue to migrate as dissolved constituents in groundwater beyond the SWDA and IWS Areas, residences within the known area impacted by groundwater contamination either have access to or are currently connected to the Village of Lyndonville's public drinking water supply. However, there are currently no institutional controls in place which prevent the use of groundwater. RI data indicate that the Passumpsic River has not been impacted by the groundwater constituents and future impacts are not expected to occur due to the effects of groundwater flushing and natural degradation processes, and the dilution capacity of the river.

Alternative 1 would not include surface water drainage/erosion controls to minimize runoff from the SWDA and IWS Areas and associated adverse sedimentation and leachate impacts to wetlands immediately adjacent to these areas.

Implementability - Alternative 1

Alternative 1 could be easily implemented, as no further action would be required other than five-year site reviews. Site reviews would be performed by trained personnel, and could be easily implemented.

Potential adverse impacts to wetlands associated with cap construction (Alternatives 2, 3, 4, 5, 7 and 8), and waste generation that would be associated with alternatives involving groundwater extraction and treatment (Alternatives 3, 5, 7, and 8) would not occur under Alternative 1.

Cost - Alternative 1

Costs for Alternative 1 would be associated with implementation of the five-year site reviews. Assuming a 30-year operational period and 7 percent interest, the order of magnitude cost of Alternative 1 is estimated to be approximately $40,000. Cost backup information is included in Appendix C.

Status/Justification - Alternative 1

While Alternative 1: No Action does not address the potential for soil contact or groundwater ingestion, it will be retained for further evaluation and comparison with other alternatives as required by the NCP. Alternative 1 is appropriate for consideration because: 1) residences within the known area impacted by groundwater contamination either have access to or are currently connected to the Town of Lyndonville's public drinking water supply, and 2) groundwater migrating from the SWDA and IWS Areas has not and is not expected to impact the Passumpsic River.

3.2.2 Alternative 2: Containment (SWDA, IWS 1, 2 and 3)

Description - Alternative 2

Alternative 2 would include capping of the SWDA and IWS Areas utilizing RCRA Subtitle C composite cap design. Alternative 2 includes the following components:

- possible temporary relocation of seven mobile homes on the northern side of the SWDA during cap construction activities;
- regrading of the SWDA;

- possible re-routing of a limited portion of the Unnamed Stream beneath or adjacent to the SWDA cap;
- construction of a composite-barrier cap on the SWDA;
- installation and operation of an active gas collection system and central gas treatment (flaring) system in SWDA and IWS Areas;
- installation of perimeter storm water ditches and a storm water retention pond to manage the surface runoff from the landfill caps;
- construction of composite-barrier (RCRA) caps on IWS 1, 2, and 3;
- revegetation of the capped areas to control erosion;
- construction of a fence around the capped areas to deter unauthorized access;
- institutional controls/deed restrictions to limit intrusive activities in the capped areas and prevent use of impacted groundwater;
- long-term groundwater, surface water, and sediment monitoring;
- possible wetlands mitigation, if adversely impacted; and
- a five-year site review to evaluate the effectiveness and adequacy of remedial measures, including an engineering review of geosynthetic performance under field conditions.

Effectiveness - Alternative 2

Alternative 2 would effectively address the risk of direct contact with Contaminants of Concern in the SWDA and IWS Areas through installation of the caps. The vegetated caps would also minimize stream and sediment impacts due to runoff from the SWDA and IWS Areas. The risk of groundwater ingestion would be addressed through institutional controls preventing groundwater use. Residences within the known area impacted by groundwater contamination either have access to or are currently connected to the Village of Lyndonville's public drinking water supply.

The composite-barrier covers would also greatly reduce the potential impact of IWS 1, 2, and 3 on groundwater. Since potential source materials within IWS Areas 1, 2, and 3 are primarily located in the unsaturated zone, the installation of impermeable caps over these areas can be expected to significantly reduce the mass-loading of Contaminants of Concern to the groundwater system from these areas. Therefore, although groundwater containing Contaminants of Concern would continue to migrate from the SWDA and IWS Areas, there should be a reduction in downgradient groundwater concentrations below the presently-observed levels even without implementation of a groundwater extraction measure. The degree of improvement and timeframe for reduction of levels to drinking water standards is not predictable within the foreseeable future, because the total mass of Contaminants of Concern that may be in the saturated zone cannot be accurately determined.

Landfill gas that is generated due to decomposition within the SWDA and IWS Areas would be collected and treated, as appropriate thereby eliminating potential buildup and migration of landfill gas and potential odors.

Due to the close proximity of several of the mobile homes to the SWDA cap construction activities that will take place along the northern and northwestern SWDA boundaries, it is anticipated that approximately seven of the mobile homes would require temporary relocation during the construction activities. There would also be an increase in truck traffic in the vicinity of the Parker Landfill and some potential risk of worker and community exposure to soil and debris during the initial cap construction activities that would need to be addressed. Cap construction may impact adjacent wetlands. This may require undertaking mitigation efforts.

The TMV of Contaminants of Concern at the SWDA and IWS Areas would not be reduced through treatment; however, the inherent hazard associated with Contaminants of Concern in the SWDA and IWS Areas and downgradient would be addressed through the cap and institutional controls. Treatment residuals would not be generated.

Long-term groundwater monitoring and five-year site reviews would be used to measure the effectiveness of Alternative 2.

Implementability - Alternative 2

The installation of RCRA caps over the SWDA and IWS Areas would utilize standard construction practices, and equipment and experienced personnel are readily available. Similarly, the temporary relocation of several mobile homes located at the northern end of the SWDA would utilize standard construction practices and could be readily completed. Installation of a cap around high-tension wires that traverse the SWDA would require additional design and installation considerations.

Potential issues associated with waste generation and treatment (which would occur under Alternatives 3, 5, 7, and 8) would not occur under Alternative 2. Active collection and flaring of landfill gas generated in the SWDA and IWS Areas would utilize standard methods of gas collection and treatment or discharge.

Based on the conceptual cap designs for the SWDA and IWS Areas, wetlands would be impacted in the northern portion of the site, where a portion of the Unnamed Stream may be routed through a culvert beneath the cap or adjacent to the SWDA cap. The primary function of the existing wetlands adjacent to the SWDA is to provide a conduit for surface water drainage from the SWDA, to stabilize sediments, to retain nutrients/toxicants from the same and to support wildlife. The design of the caps for the SWDA and IWS Areas would include a storm water system including a detention pond which could be incorporated into engineered wetlands mitigation after establishment of vegetative cover on the cap system. Wetland vegetation species could be incorporated into the engineered wetlands. The loss of potential habitat caused by encroachment of the cap into the existing wetlands could be offset by an increase in the area of open water and water edge planted with wetland vegetation species, which would attract wetland-dependent birds.

Installation of fencing around the SWDA and IWS Areas could be easily implemented. Institutional controls and/or deed restrictions are also implementable. A public water supply is available to the impacted area, facilitating institutional controls preventing groundwater use, but implementation of these controls would require the cooperation of landowners, the Town, and the State of Vermont. Long-term monitoring of groundwater, surface water, and sediments within the Unnamed Stream and Passumpsic River, as well as five-year site reviews, would be easily implemented. Experienced and trained personnel required to perform these activities are readily available.

Cost - Alternative 2

Assuming a 30-year operational period and 7 percent interest, order of magnitude costs for Alternative 2 would be approximately $13,000,000. Costs are primarily associated with the installation of caps at the SWDA and IWS Areas. Cost backup information is included in Appendix C.

Status/Justification - Alternative 2

Alternative 2 will be retained for further evaluation. Alternative 2 is appropriate for consideration because: 1) the caps would minimize the potential for direct contact with Contaminants of Concern; 2) institutional controls would effectively address health and environmental risk concerns by preventing the ingestion of groundwater containing constituents above remediation goals; 3) residences within the known area impacted by groundwater contamination either have access to or are currently connected to the Village of Lyndonville's public drinking water supply; 4) the cap would minimize leachate generation and migration into the adjacent wetlands, and also minimize impacts from surface water runoff; 5) construction of caps on the SWDA and IWS Areas (the presumptive remedy) would effectively eliminate the movement of constituents from source materials within the unsaturated zone in these areas; 6) the concentrations of Contaminants of Concern downgradient of the SWDA and IWS Areas would be reduced from the present levels due to the effect of the caps and via natural dispersion and degradation processes; and 7) monitoring of groundwater would track the migration of Contaminants of Concern.

3.2.3 Alternative 3: Containment (SWDA, IWS 1, 2, and 3)/Source Control Groundwater Extraction and Treatment

Description - Alternative 3

Alternative 3 is similar to Alternative 2, except that a groundwater extraction system would be designed and installed to prevent the migration of groundwater containing Contaminants of Concern above the remediation goals beyond the area encompassing the SWDA and IWS Areas.

Alternative 3 would involve similar components as those included under Alternative 2, as follows (additional or modified measures are shown in bold type):

- possible temporary relocation of seven mobile homes on the northern side of the SWDA during cap construction activities;
- regrading of the SWDA to achieve appropriate slopes and drainage for the cap;
- possible re-routing of a limited portion of the Unnamed Stream beneath or adjacent to the SWDA cap;
- construction of a composite-barrier (RCRA) cap on the SWDA;
- installation and operation of an active gas collection system and central gas treatment (flaring) system in SWDA and IWS Areas;
- installation of perimeter storm water ditches and a storm water retention pond to manage the surface runoff from the caps;
- construction of a composite-barrier (RCRA) cap on IWS 1, 2, and 3;
- revegetation of the capped areas to control erosion;
- construction of a fence around the capped areas to deter unauthorized access;
- possible wetlands mitigation, if adversely impacted;

- **extraction of groundwater to prevent the off-site flow of groundwater that has contacted waste materials currently acting as contaminant sources and containing concentrations exceeding the remediation goals;**

- **groundwater treatment by air stripping with vapor-phase carbon treatment and granular activated carbon (GAC) polishing (an alternate technology may be selected during the design phase); this treatment requires a pretreatment step consisting of inorganics removal using carbonate/hydroxide precipitation;**

- **discharge of treated groundwater to the Passumpsic River. Groundwater would be treated to obtain the levels necessary to comply with NPDES program requirements (alternatives to discharging treated water to the Passumpsic River will be evaluated during pre-design);**

- **long-term maintenance, monitoring of the groundwater treatment system;**

- **off-site disposal and/or further treatment or destruction of treatment residuals;**

- institutional controls/deed restrictions to limit intrusive activities in the capped area and prevent use of impacted groundwater containing constituents above remediation goals;

- long-term groundwater, surface water, and sediment monitoring; and

- a five-year site review to evaluate the effectiveness and adequacy of remedial measures, including engineering review of geosynthetic performance under field conditions.

Approximately four wells would be screened in the overburden and one well in the fractured bedrock. The bedrock well would be located in the upper 50 feet of bedrock, just downgradient of IWS 2. This well would be pumped at approximately 15 gpm. The overburden wells would be fully screened in the Lower Proximal. As shown on Figure 3-1, these four wells would be located on a line downgradient of IWS 1 and IWS 2, at spacings of 250 to 280 feet. These wells would be pumped at between 15 gpm and 25 gpm, at a combined rate of approximately 84 gpm. The total source control extraction system would have a combined overburden and bedrock pumping rate of approximately 100 gpm.

To evaluate the treatment requirements for a source control groundwater extraction system, contaminants of primary concern and concentrations of those contaminants were determined from the pumping test analysis performed in 1993. These analyses showed a very hard groundwater with some elevated concentrations of metals, VOC (including ketones), chlorinated solvents, cyclical aromatics, phenols, phthalates, and alcohols. Elevated iron levels (>70 ppm) in the groundwater would inhibit many forms of treatment, increase clogging of equipment and systems, and provide a media for iron bacteria growth. Groundwater hardness above 1,200 ppm would also lead to the increased potential for precipitation and build-up on water treatment equipment, as well as increasing loading on many types of available treatment (such as ion exchange). Groundwater would require softening, and hardness, as well as metals would be addressed through precipitation with hydroxide and carbonate formation. Precipitates would be removed in a clarifier, with groundwater flowing through a filter prior to entering an air stripping column. Groundwater treated in the air stripping column would flow through an activated carbon column for polishing, if necessary. Air discharge from the air stripping column might need to be treated with vapor phase carbon adsorption. The treated groundwater would be discharged into the Passumpsic River. Analysis of outfall location would be incorporated in developing effluent quality criteria under the NPDES program. This toxicity based criteria may result in development of effluent limits which are technologically difficult to achieve. Predesign studies incorporating bioassay analysis will be utilized to help derive achievable treatment standards. Alternatives to discharging treated water to the Passumpsic River will be evaluated during pre-design.

The institutional controls and groundwater monitoring program implemented for this alternative would be similar to those described for Alternative 2, although the monitoring program may be modified to confirm the capture zones of the extraction wells. A five-year site review would be performed to confirm the effectiveness of the remedial measures implemented as part of Alternative 3.

Effectiveness - Alternative 3

As discussed under Alternative 2, the caps over the SWDA and IWS Areas would effectively address the risk of direct contact with Contaminants of Concern in these areas. The vegetated cap would also minimize stream and sediment impacts due to surface water runoff. Institutional controls would address the risk of groundwater ingestion by preventing impacted groundwater use. Residences within the known area impacted by groundwater contamination either have access to or are currently connected to the Village of Lyndonville's public drinking water supply.

Under Alternative 3, the source control groundwater extraction system would effectively intercept the flow of contaminated groundwater from the area encompassing the SWDA and IWS Areas. However, because there may continue to be source materials within the saturated zone within the contained area, concentrations of Contaminants of Concern within the area encompassing the SWDA and IWS Areas and in the extraction wells could remain greater than the remediation goals for a time period that is unpredictable for the foreseeable future. Under Alternative 3, downgradient groundwater concentrations would not achieve remediation goals for approximately 60 years following installation and start-up of the extraction system.

The potential wetlands impacts associated with cap construction discussed under Alternative 2 would also apply to Alternative 3. Water table lowering due to groundwater extraction is expected to be in the range of 1.5 to 2 feet. The portion of the Unnamed Stream upgradient of IWS 2 is separated from the Lower Proximal by the low permeability Distal. The Distal acts as a semi-confining layer in this area and drawdown effects are therefore not expected to propagate through the Distal into the Upper Proximal. Because of the 11 to 15 foot separation between the lower reaches of the Unnamed Stream and the water table, the 1.5 to 2 feet of drawdown resulting from groundwater pumping is expected to have no impact upon those reaches of the stream. Therefore, impacts to wetlands due to operation of the groundwater extraction system would be minimal. As described previously, the vegetated cap would minimize adverse impacts to adjacent wetlands associated with surface water runoff and erosion from the SWDA and IWS Areas.

The TMV of Contaminants of Concern captured by the groundwater extraction system would be reduced via treatment; however, the overall toxicity of the contaminants would be transferred to the treatment residual (sludge formed during metal pretreatment; vapor-phase carbon and activated carbon), which would require off-site disposal and/or further treatment or destruction. Furthermore, this TMV reduction would not significantly reduce the inherent hazard posed by Contaminants of Concern at the site, since these hazards would be primarily controlled by the caps and institutional controls.

As discussed under Alternative 2, landfill gas that is generated due to decomposition within the RCRA capped area would be actively collected and treated, thereby eliminating potential buildup and migration of landfill gas and potential odors.

Institutional controls, in conjunction with capping and installation of fencing, would effectively eliminate direct contact with soil and debris and prevent intrusive activities within the capped areas.

A long-term groundwater monitoring plan and five-year site reviews would be used to measure the effectiveness of Alternative 3.

Implementability - Alternative 3

The installation of extraction and monitoring wells required under Alternative 3 would utilize conventional well installation techniques. The placement, installation and operation of extraction wells would be performed in a manner that would minimize potential remobilization of contaminants that may be present in the saturated zone. Treatment of extracted groundwater would utilize readily available equipment. Treatment residuals would be generated and appropriate disposal would be required. A minimum of 3,000 feet of discharge piping would be required for discharge of treated water to the Passumpsic River. While construction of the discharge line would require conventional construction techniques, numerous easements would be necessary and potential disruption of vehicular and railroad traffic along the path of the discharge piping may occur. Although a discharge permit would not be required, treatment to comply with all substantive requirements of the NPDES program would be mandatory. Once effluent quality criteria have been determined the technical feasibility of achieving those criteria will be resolved. Effluent limits will have a substantial impact on groundwater treatment system design.

As discussed above, the construction of the SWDA cap and the extraction of groundwater may impact surrounding wetlands areas, which could require replacement. The primary function of the existing wetlands adjacent to the SWDA is to provide a conduit for surface water drainage from the SWDA, to stabilize sediments, to retain nutrients/toxicants from the same and to support wildlife. The design of the caps for the SWDA and IWS Areas will include a storm water system including a detention pond which could be incorporated into engineered wetlands after establishment of a vegetative cover on the cap system.

The technical and administrative implementability considerations discussed under Alternative 2 associated with installation of RCRA caps on the SWDA and IWS Areas and implementation of institutional controls would apply.

<u>Cost - Alternative 3</u>

Assuming a 30-year operational period and 7 percent interest, the order of magnitude cost for Alternative 3 would be approximately $28,100,000. Costs are primarily associated with the construction of the caps and extraction and treatment of contaminated groundwater. Cost backup information is included in Appendix C.

<u>Status/Justification - Alternative 3</u>

Alternative 3 is retained for further evaluation, since it would minimize the potential groundwater transport of Contaminants of Concern from the area encompassing the SWDA and IWS Areas in groundwater, while preventing movement of constituents from the unsaturated zone in the SWDA and IWS Areas.

3.2.4 Alternative 4: Containment (SWDA, IWS 1, 2, and 3)/In-situ Soil Vapor Extraction of IWS 2 Area/No Source Control Groundwater Extraction

Description - Alternative 4

Alternative 4 would supplement capping Alternative 2 with the installation and operation of a soil-vapor extraction (SVE) system to remove VOC located within IWS 2. Alternative 4 would involve components similar to those included under Alternative 2, as follows (additional or modified measures are shown in bold type):

- possible temporary relocation of seven mobile homes on the northern side of the SWDA during cap construction activities;
- regrading of the SWDA to achieve appropriate slopes and drainage for cap;
- possible re-routing of a limited portion of the Unnamed Stream beneath or adjacent to the SWDA cap;
- construction of a composite-barrier (RCRA) cap on the SWDA;
- installation and operation of an active gas collection system and central gas treatment (flaring) system in SWDA and IWS Areas;
- installation of perimeter storm water ditches and a storm water retention pond to manage the surface runoff from the caps;
- construction of composite-barrier (RCRA) caps on IWS 1, 2, and 3;
- revegetation of the capped areas to control erosion;
- construction of a fence around the capped areas to deter unauthorized access;
- possible wetlands mitigation, if adversely impacted;
- **design and installation of a soil vapor extraction (SVE) system within IWS 2;**

- **long-term (15 years) monitoring and maintenance of the soil vapor extraction system;**
- **air treatment by granular activated carbon (GAC) polishing (an alternative technology may be selected during design phase);**
- **off-site disposal and/or further treatment or destruction of SVE treatment system residuals;**
- institutional controls/deed restrictions to limit intrusive activities in the capped area and prevent use of impacted groundwater containing constituents above remediation goals;
- long-term groundwater, surface water, and sediment monitoring; and
- a five-year site review to evaluate the effectiveness and adequacy of remedial measures, including an engineering review of geosynthetic performance under field conditions.

Vacuum extraction involves the installation of surface-mounted air vacuum pumping equipment and a network of buried vacuum lines or extraction wells located in target areas of known volatile constituents present in the unsaturated zone. As the lines are evacuated, volatile compounds in the vadose zone partition to the air phase and migrate to the vacuum collection system.

Effectiveness - Alternative 4

As discussed under Alternative 2, the caps over the SWDA and IWS Areas would effectively address the risk of direct contact with Contaminants of Concern in these areas. The vegetated cap would also minimize stream and sediment impacts due to surface water runoff. Institutional controls would address the risk of groundwater ingestion by preventing impacted groundwater use. Residences within the known area impacted by groundwater contamination either have access to or are currently connected to the Village of Lyndonville's public drinking water supply.

The impermeable caps will also reduce or eliminate rainfall infiltration through source material within the unsaturated zone and resulting impacts to groundwater and adjacent wetlands. Since potential source materials within IWS Areas 1, 2 and 3 are primarily located in the unsaturated zone, the installation of the caps can be expected to significantly reduce the mass-loading of Contaminants of Concern to the groundwater system from these areas, and result in a reduction in groundwater concentrations below the presently observed levels.

Following installation and start up of the SVE system, VOC within the IWS 2 Area would be extracted from unsaturated soil. However, the effectiveness of SVE within IWS 2 may be limited, since sufficient air flow through the soil may not be achieved due to the heterogeneity and low permeability of materials (see Implementability Evaluation). The vacuum extraction system would have little effect on PAH, semi-volatile organic compounds (SVOC), or metals.

Since materials within the unsaturated zone would be isolated by the cap alone, the only additional benefit associated with Alternative 4 would be a reduction of TMV. However, the overall toxicity of the contaminants would be transferred to the treatment residual, which would require off-site disposal, treatment, recycling or destruction. VOC removal and treatment under this alternative would not significantly reduce the inherent hazard posed by these contaminants, since the human health and environmental risk posed by the VOC within IWS 2 would be primarily controlled through capping and institutional controls.

The majority of the source materials within IWS 2 are located in the unsaturated zone. If there are source materials within the saturated zone in the area encompassing the SWDA and IWS Areas, they would not be addressed by the SVE system in IWS 2. RI data indicate that levels of Contaminants of Concern decrease significantly below the water table at IWS 2. Additionally, groundwater data indicate that the IWS 2 Area is not significantly impacting downgradient groundwater even under current conditions (without a cap). The concentrations of Contaminants of Concern in IWS 2 groundwater are 1.5 to 2 orders of magnitude lower than observed in the groundwater in other IWS Areas. Therefore, source reduction within the IWS 2 Area is not expected to significantly impact groundwater quality.

Under Alternative 4, groundwater containing Contaminants of Concern would continue to migrate beyond the SWDA and IWS Areas. Concentrations of Contaminants of Concern could remain greater than remediation goals, but would be reduced due to the effect of the caps and by groundwater flushing, dispersion and natural degradation. The degree of groundwater quality improvement and timeframe for reduction of levels to remediation goals is not predictable within the foreseeable future. However, as stated previously, residences within the known area impacted by groundwater contamination either have access to or are currently connected to the Town of Lyndonville's public drinking water supply.

The long term groundwater monitoring plan and five-year site review would be used to measure the effectiveness of Alternative 4.

Implementability - Alternative 4

The technical and administrative implementability considerations discussed under Alternative 2 associated with design and construction of RCRA caps over the SWDA and IWS Areas, potential adverse impacts to wetlands, and implementation of institutional controls would apply. Regulatory issues associated with treated groundwater discharge requirements, and waste generation from groundwater extraction and treatment that would be associated with Alternatives 3, 5, 7, and 8, would not occur under Alternative 4.

Implementation of an SVE system at IWS 2 may be difficult due to the heterogeneity of waste materials and presence of low permeability soil and the resultant limited capture zone of an SVE system. Because of the low permeability of the soils in this area and the presence of debris, vapor movement could occur along preferred pathways, resulting in channeling. Because of this, the potential exists for constituents to be removed from along these preferred pathways, while other high-concentration areas would remain.

Cost - Alternative 4

Assuming a 30-year operational period and 7 percent interest, the order of magnitude cost for Alternative 4 would be approximately $15,300,000. Cost backup information is included in Appendix C.

Status/Justification

Even though the potential effectiveness and benefits of Alternative 4 may be limited due to site-specific conditions and the presumptive remedy, which would also address the unsaturated zone, Alternative 4 is retained for further evaluation since it would provide for a reduction in TMV.

3.2.5 Alternative 5: Containment (SWDA, IWS 1, 2, and 3)/In-situ Soil Vapor Extraction of IWS 2/Source Control Groundwater Extraction

Description - Alternative 5

Alternative 5 would supplement Alternative 3 (capping and source control groundwater extraction) with the installation and operation of a SVE system to remove volatile organic compounds located within IWS 2. Alternative 5 would involve components similar to those included under Alternative 3, as follows (additional or modified measures are shown in bold type):

- possible temporary relocation of seven mobile homes on the northern side of the SWDA during cap construction activities;
- regrading of the SWDA;
- possible re-routing of a limited portion of the Unnamed Stream beneath or adjacent to the SWDA cap;
- construction of a composite-barrier (RCRA) cap on the SWDA;

- installation and operation of an active gas collection system and central gas treatment (flaring) system in SWDA and IWS Areas;
- installation of perimeter storm water ditches and a storm water retention pond to manage the surface runoff from the caps;
- construction of composite-barrier (RCRA) caps on IWS 1, 2, and 3;
- revegetation of the capped areas to control erosion;
- construction of a fence around the capped areas to deter unauthorized access;
- possible wetlands mitigation, if adversely impacted;
- **design and installation of a soil vapor extraction (SVE) system within IWS 2;**
- **long-term (15 year) monitoring and maintenance of the SVE system;**
- **air treatment by GAC polishing (an alternative technology may be selected during the design phase);**
- **off-site disposal and/or further treatment or destruction of SVE treatment system residuals;**
- extraction of groundwater to prevent the off-site flow of groundwater that contains concentrations exceeding the remediation goals (see Alternative 3 description);
- groundwater treatment followed by air stripping and GAC polishing; this treatment requires a pretreatment step consisting of inorganics removal using carbonate/hydroxide precipitation;
- discharge of treated groundwater to the Passumpsic River in accordance with NPDES program requirements (alternatives to discharging treated water to the Passumpsic River will be evaluated during pre-design);
- long-term maintenance, monitoring of the groundwater treatment system;
- off-site disposal and/or further treatment or destruction of treatment residuals;

- institutional controls/deed restrictions to limit intrusive activities in the capped area and prevent use of impacted groundwater containing constituents above remediation goals;

- long-term groundwater, surface water, and sediment monitoring; and

- five-year site reviews to evaluate the effectiveness and adequacy of remedial measures, including engineering review of geosynthetic performance under field conditions.

Effectiveness - Alternative 5

As discussed under Alternative 2, the caps over the SWDA and IWS Areas would effectively address the risk of direct contact with Contaminants of Concern in these areas. The vegetated cap would also minimize stream and sediment impacts due to surface water runoff. Institutional controls would address the risk of groundwater ingestion by preventing impacted groundwater use. Residences within the known area impacted by groundwater contamination either have access to or are currently connected to the Village of Lyndonville's public drinking water supply.

The impermeable caps will also reduce or eliminate rainfall infiltration through source material within the unsaturated zone and resulting impacts to groundwater and adjacent wetlands. Since potential source materials within IWS Areas 1, 2 and 3 are primarily located in the unsaturated zone, the installation of the caps can be expected to significantly reduce the mass-loading of Contaminants of Concern to the groundwater system from these areas and there should be a reduction in groundwater concentrations below the presently observed levels even without implementation of groundwater extraction and treatment.

The source control groundwater extraction system would effectively intercept the flow of contaminated groundwater from the area encompassing the SWDA and IWS Areas 1, 2, and 3. Following installation and start up of the source control groundwater extraction system, further migration of groundwater containing Contaminants of Concern at concentrations above the remediation goals within the area encompassing the SWDA and IWS Areas would be prevented.

However, concentrations of Contaminants of Concern within the contained area and in the extraction wells could remain greater than the remediation goals for a time period that is unpredictable for the foreseeable future. Downgradient of the extraction system, groundwater would not reduce to remediation goals for approximately 60 years.

The potential wetlands impacts (adverse and beneficial) associated with the caps discussed under Alternative 2 would also apply to Alternative 5. As with Alternative 3, adverse impacts to wetlands due to operation of the groundwater extraction system would be minimal.

Following installation and start up of the SVE system, VOC would be extracted from unsaturated soil within the IWS 2 Area. The vacuum extraction system would have little effect on PAH, SVOC or metals. The SVE system would not address Contaminants of Concern located within the saturated zone. SVE would result in a reduction of TMV; however, the overall toxicity of the contaminants would be transferred to the treatment residual, which would require off-site disposal, recycling, treatment or destruction. The potential problems associated with the effectiveness of the SVE system discussed under Alternative 4 would apply to Alternative 5.

As with Alternative 4, the benefits of SVE would be limited under Alternative 5 since Contaminants of Concern located within the unsaturated zone in IWS 2 would be effectively isolated upon completion of the cap. The cap alone would eliminate the potential for direct contact with waste materials in IWS 2 and would prevent further movement via rainfall infiltration from these materials to groundwater.

The long-term groundwater monitoring plan and five-year site review would be used to measure the effectiveness of Alternative 5.

Implementability - Alternative 5

The technical and administrative implementability considerations discussed previously for Alternatives 2, 3, and 4 associated with design and construction of RCRA caps over the SWDA and IWS Areas; installation and operation of the groundwater and SVE extraction systems;

treatment, piping and discharge of treated groundwater from the SWDA and IWS Areas to the Passumpsic River; and implementation of institutional controls would also apply to Alternative 5.

As discussed in the evaluation of Alternative 4, implementation of an SVE system at IWS 2 may be difficult due to the heterogeneity of waste materials and presence of low permeability soil and the resultant limited capture zone of an SVE system. Because of the low permeability of the soils in this area and the presence of metal debris, vapor movement is likely to occur along preferred pathways, resulting in channeling. Because of this, the constituents would be removed from along these preferred pathways, while other high-concentration areas would remain.

Cost - Alternative 5

The costs associated with Alternative 5, assuming a 30-year operational period and 7 percent interest would be approximately $29,700,000. Cost backup information is included in Appendix C.

Status/Justification - Alternative 5

Even though the potential effectiveness and benefits of Alternative 5 may be limited due to site-specific conditions and the presumptive remedy, Alternative 5 is retained for further evaluation since it would provide for a reduction in TMV.

3.2.6 Alternative 6: Containment (SWDA, IWS 1 and 3)/Excavation and Off-Site Incineration of IWS 2 Materials/No Source Control Groundwater Extraction

Description - Alternative 6

Alternative 6 would supplement capping Alternative 2 with excavation and off-site incineration of IWS 2 material. Components similar to those included under Alternative 2 would be included, as follows (additional or modified measures are shown in bold type):

- **excavation of IWS 2 materials;**
- **backfilling of IWS 2 Area with clean fill;**
- **transport of excavated IWS 2 materials to off-site incinerator;**
- **off-site incineration of excavated IWS 2 materials;**
- possible temporary relocation of seven mobile homes on the northern side of the SWDA during cap construction activities;
- regrading of the SWDA to achieve appropriate slopes and drainage for cap;
- possible re-routing of a limited portion of the Unnamed Stream beneath or adjacent to the SWDA cap;
- construction of a composite-barrier (RCRA) cap on the SWDA;
- installation and operation of an active gas collection system and central gas treatment (flaring) system in SWDA and IWS Areas;
- installation of perimeter storm water ditches and a storm water retention pond to manage the surface runoff from the caps;
- construction of composite-barrier (RCRA) caps on IWS 1 and 3. A cap would not be required on IWS 2 since unsaturated zone contamination would be removed;
- revegetation of the capped areas to control erosion;
- institutional controls/deed restrictions to limit intrusive activities in the capped area and prevent use of impacted groundwater;
- construction of a fence around the capped areas to deter unauthorized access;
- long-term groundwater, surface water, and sediment monitoring;
- possible wetlands mitigation, if adversely impacted; and

- five-year review to evaluate the effectiveness of the measures implemented, including engineering review of geosynthetic performance under field conditions.

An estimate of the volume to be excavated (approximately 2,000 to 3,000 yd^3) has been developed for use in the FS evaluation based on GPR and test pit data. This estimate assumes that only waste material and a limited volume of unsaturated soil beneath the waste material would be excavated. If it is necessary to excavate material from the saturated zone beneath IWS 2, not only would the volume be greater, but dewatering would also be required. Depending on the degree of water table lowering necessary, dewatering may be difficult to implement. Treatment and discharge of water extracted during dewatering would be necessary.

Effectiveness - Alternative 6

As discussed under Alternative 2, the caps over the SWDA and IWS Areas would effectively address the risk of direct contact with Contaminants of Concern in these areas. The vegetated cap would also minimize stream and sediment impacts due to surface water runoff. Institutional controls would address the risk of groundwater ingestion by preventing impacted groundwater use. Residences within the known area impacted by groundwater contamination either have access to or are currently connected to the Village of Lyndonville's public drinking water supply.

The impermeable caps will also reduce or eliminate rainfall infiltration through source material within the unsaturated zone and resulting impacts to groundwater and adjacent wetlands. Since potential source materials within IWS Areas 1, 2 and 3 are primarily located in the unsaturated zone, the installation of the caps can be expected to significantly reduce the mass-loading of Contaminants of Concern to the groundwater system from these areas. Therefore, there should be a reduction in groundwater concentrations below the presently observed levels even without implementation of groundwater extraction and treatment, although groundwater containing Contaminants of Concern would continue to migrate from the SWDA and IWS Areas.

Since the cap alone would isolate IWS 2 materials within the unsaturated zone, there would be limited additional benefit associated with excavation and treatment of the materials. If source materials remain within the saturated zone in the SWDA and IWS Areas following excavation of IWS 2, they would continue to contribute constituents directly to groundwater. However, RI data indicate that levels of Contaminants of Concern decrease significantly below the water table at IWS 2. Additionally, groundwater data collected during the RI do not indicate that IWS 2 is a significant source of groundwater contamination even under existing conditions (without a cap). The concentrations of Contaminants of Concern in IWS 2 groundwater are 1.5 to 2 orders of magnitude lower than observed in the groundwater in other IWS Areas. Therefore, regardless of the extent of excavation, the removal of IWS 2 materials is not expected to result in a significant change in downgradient groundwater quality, and would not have a significant impact on any risk posed by the Parker Landfill or the remediation time frame.

During excavation and handling activities there would be a high potential for worker and community exposure to the Contaminants of Concern present in the excavated soil and debris. A comprehensive health and safety program would need to be implemented. In addition, there would be some risk of mobilizing Contaminants of Concern during excavation and increasing the extent of subsurface contamination.

Off-site incineration of IWS 2 material and treatment of groundwater extracted during dewatering would remove toxicity from the Parker Landfill, but would simply transfer this toxicity elsewhere. Incineration effectively reduces VOC and PAH. Most metals would not be reduced, however. The resulting ash may be considered hazardous and would require appropriate disposal. Groundwater treatment residuals would also be generated and would require appropriate disposal.

The long term groundwater monitoring plan and five-year site review would be used to measure the effectiveness of Alternative 6.

Implementability - Alternative 6

The implementability considerations associated with other capping alternatives (see Alternative 2) would apply. Excavation activities utilize fairly standard materials handling and disposal techniques. Equipment and experienced personnel are available. Dewatering, if required during excavation, utilizes standard construction practices. Treatment and/or disposal of the water generated during dewatering would be necessary.

Wetlands impacts associated with cap construction (see Alternative 2) would occur under Alternative 6 as well. Waste generation that would be associated with alternatives involving groundwater extraction and treatment (Alternatives 3, 5, 7, and 8) would not occur under Alternative 6.

The technical implementability considerations for implementation of excavation and off-site incineration of IWS 2 materials include problems associated with limited staging area in the vicinity of IWS 2 and potentially insufficient space for access roads capable of supporting heavy construction and transport equipment. Excavation activities could disturb and remobilize DNAPL accumulations, if present, and worsen the extent of contamination. If excavation of saturated soil is necessary, there would be significant implementability concerns. It may be necessary to extract and treat large volumes of groundwater in order to adequately dewater materials beneath IWS 2. Clean fill that is backfilled into the excavation may become recontaminated due to contact with groundwater containing Contaminants of Concern.

Long distance transport to an off-site incineration facility is likely. The closest currently available off-site facility is located in New Jersey. Depending on the requirements of the incineration facility, transport as far as Texas or Utah could be required.

Compliance with a comprehensive health and safety program and airborne dust control measures would be necessary during excavation, handling and transport activities to address potential worker and community exposure during these activities.

Cost - Alternative 6

Assuming a 30-year operational period and 7 percent interest, the order of magnitude cost for Alternative 6 would be approximately $25,000,000. Cost backup information is included in Appendix C.

Status/Justification

Alternative 6 would offer very limited additional benefits and minimal risk reduction relative to other alternatives, yet would be more costly to implement and would pose significant potential worker and community exposure and implementability concerns. Therefore, this alternative is eliminated from further consideration. This is consistent with EPA guidance, which states that hot spot excavation and removal is only appropriate if remediation will "significantly reduce the risk posed by the overall site."

3.2.7 Alternative 7: Containment (SWDA, IWS 1, 2, and 3)/Excavation and Off-Site Incineration of IWS 2 Materials/Source Control Groundwater Extraction

Description - Alternative 7

Alternative 7 would supplement Alternative 3 with excavation and off-site incineration of IWS 2 material. Components similar to those included under Alternative 3 would be included, as follows (additional or modified measures are shown in bold type):

- **excavation of IWS 2 materials;**
- **backfill IWS 2 Area with clean fill;**
- **transport of excavated IWS 2 materials to off-site incinerator;**
- **off-site incineration of excavated IWS 2 materials;**

- possible temporary relocation of seven mobile homes on the northern side of the SWDA during cap construction activities;

- regrading of the SWDA to achieve appropriate slopes and drainage for cap;

- possible re-routing of a limited portion of the Unnamed Stream beneath or adjacent to the SWDA cap;

- construction of a composite-barrier (RCRA) cap on the SWDA;

- installation and operation of an active gas collection system and central gas treatment (flaring) system in SWDA and IWS Areas;

- installation of perimeter storm water ditches and a storm water retention pond to manage the surface runoff from the caps;

- construction of composite-barrier (RCRA) caps on IWS 1 and 3. A cap on IWS 2 would not be required since unsaturated contamination would be removed;

- revegetation of the capped areas to control erosion;

- extraction of groundwater to prevent the off-site flow of groundwater that contains concentrations exceeding the remediation goals;

- groundwater treatment by air stripping with vapor-phase carbon treatment and GAC polishing; this treatment requires a pretreatment step consisting of inorganics removal using carbonate/hydroxide precipitation;

- discharge of treated groundwater to the Passumpsic River in accordance with NPDES program requirements (alternatives to discharging treated water to the Passumpsic River will be evaluated during pre-design);

- long-term monitoring and maintenance of the groundwater treatment system;

- off-site disposal and/or further treatment or destruction of treatment residuals;

- institutional controls/deed restrictions to limit intrusive activities in the capped areas and prevent use of impacted groundwater;

- construction of a fence around the capped areas to deter unauthorized access;

- long-term groundwater, surface water, and sediment monitoring;
- possible wetlands mitigation, if adversely impacted; and
- five-year review to evaluate the effectiveness of the measures implemented, including an engineering review of geosynthetic performance under field conditions.

An estimate of the volume to be excavated (approximately 2,000 to 3,000 yd^3) has been prepared for use in the FS evaluation based on GPR and test pit data. As with Alternative 6, this estimate assumes that only waste material and a limited volume of unsaturated soil beneath the waste material would be excavated. If it is necessary to excavate material from the saturated zone beneath IWS 2, not only would the volume be greater, but dewatering would also be required. Treatment and discharge of water extracted during dewatering would be necessary.

Alternative 7 would include capping as described under Alternative 2, a groundwater extraction and treatment system described under Alternative 3, and excavation and off-site incineration of IWS 2 material to remove VOC located within IWS 2, as described under Alternative 6.

Effectiveness - Alternative 7

As with Alternatives 2, 3, 4, 5, and 6, the caps alone would minimize the potential for direct contact with Contaminants of Concern in soil and minimize stream and sediment impacts. The risk of groundwater ingestion would be addressed through institutional controls. The caps would also significantly reduce the potential for movement of constituents from the SWDA and IWS Areas to groundwater. Specific effectiveness considerations associated with capping of the SWDA and IWS Areas are discussed under Alternatives 2 and 3.

Following installation and start up of the source control groundwater extraction system, further migration of groundwater containing Contaminants of Concern greater than the remediation goals from the area encompassing the SWDA and IWS Areas would be prevented. As with Alternative 3, the levels of Contaminants of Concern within the area contained by the extraction system could remain above groundwater standards, but would be reduced due to the effect of the caps and by groundwater flushing, dispersion, and natural degradation. Since the mass of Contaminants of Concern that may be in the saturated zone in the area encompassing the SWDA and IWS Areas cannot be reliably determined, the degree of groundwater quality improvement and timeframe for reduction to remediation goals is not predictable within the foreseeable future. Downgradient groundwater concentrations would not achieve remediation goals for approximately 60 years following installation and start up of the extraction system.

Potential adverse wetlands impacts associated with implementation of Alternative 7 would include those discussed under Alternatives 2 and 3. In addition, there is the potential for adverse wetlands impacts during excavation in IWS 2, since it is located in the vicinity of the Unnamed Stream.

As stated previously, the caps alone would greatly reduce the impact of the IWS Areas to groundwater, since the waste materials within these areas are located in the unsaturated zone. Groundwater data collected during the RI do not indicate that source materials within IWS 2 are significantly impacting downgradient groundwater even under existing conditions (without a cap). Therefore, removal and incineration of IWS 2 material would not have a significant impact on any risk posed by the Parker Landfill and would not have a significant impact on the groundwater remediation time frame.

The TMV of Contaminants of Concern in the SWDA and IWS Areas would be reduced via treatment; however, the overall toxicity of the contaminants would be transferred to the treatment residual, which would require off-site disposal and/or treatment.

The long-term groundwater monitoring plan and five-year site review would be used to measure the effectiveness of Alternative 7.

Implementability - Alternative 7

The technical and administrative implementability considerations discussed under other alternative evaluations associated with design and construction of RCRA caps over the SWDA and IWS Areas; installation and operation of the groundwater system; treatment, piping, and discharge of treated groundwater from the SWDA and IWS Areas to the Passumpsic River; and implementation of institutional controls would also apply to this alternative.

The technical implementability considerations for implementation of excavation and off-site incineration of IWS 2 materials include numerous potential problems as described under Alternative 6.

Cost - Alternative 7

The order of magnitude cost associated with Alternative 7, assuming a 30-year operational period and 7 percent interest, would be high relative to other alternatives, (approximately $40,100,000). Cost backup information is included in Appendix C.

Status/Justification - Alternative 7

As with Alternative 6, Alternative 7 would offer very limited additional benefits and minimal risk reduction relative to other alternatives, yet would be more costly to implement and would pose significant potential worker and community exposure and implementability concerns. Therefore, this alternative is eliminated from further consideration. This is consistent with EPA guidance, which states that hot spot excavation and removal is only appropriate if remediation will "significantly reduce the risk posed by the overall site."

3.2.8 Alternative 8A: Downgradient Groundwater Extraction/Combined with Alternatives 2 or 4

Alternative 8A would supplement Alternative 2: Containment/No Source Control Groundwater Extraction or Alternative 4: Containment/In-Situ Soil Vapor Extraction of IWS 2 Area/No Source Control Groundwater Extraction with a downgradient groundwater extraction system (management of migration (MOM) system). Alternative 8A combined with Alternative 6 is not considered further, since Alternative 6 was eliminated from further consideration in Section 3.2.6. The MOM system would contain contaminated groundwater that has been detected downgradient of the area encompassed by the SWDA and IWS Areas. Alternative 8A would include the following measures (components that are not also included in Alternatives 2 or 4 are presented in bold type):

- possible temporary relocation of seven mobile homes on the northern side of the SWDA during cap construction activities;
- regrading of the SWDA to achieve appropriate slopes and drainage for cap;
- possible re-routing of a limited portion of the Unnamed Stream beneath or adjacent to the SWDA cap;
- construction of a composite-barrier (RCRA) cap on the SWDA;
- installation and operation of an active gas collection system and central gas treatment (flaring) system in SWDA and IWS Areas;
- installation of perimeter storm water ditches and a storm water retention pond to manage the surface runoff from the caps;
- construction of composite-barrier (RCRA) caps on IWS 1, 2, and 3;
- design and installation of a soil vapor extraction (SVE) system within IWS 2 (only if combined with Alternative 4);
- long-term (15 years) monitoring and maintenance of the SVE system (only if combined with Alternative 4);
- treatment of air extracted by SVE system by GAC polishing (only if combined with Alternative 4);
- off-site disposal and/or further treatment or destruction of SVE treatment system residuals (only if combined with Alternative 4);
- revegetation of the capped areas to control erosion;

- **extraction of groundwater downgradient of the area encompassing the SWDA and IWS Areas at the known southerly extent of the contaminant plume (MOM system);**
- **treatment of extracted groundwater by air stripping and GAC polishing (or an alternative technology that may be selected during the design phase); this treatment requires a pretreatment step consisting of hydroxide/carbonate precipitation to remove inorganics;**
- piping and discharge of treated groundwater to the Passumpsic River in accordance with NPDES program requirements (alternatives to discharging treated water to the Passumpsic River will be evaluated during pre-design);
- institutional controls/deed restrictions to limit intrusive activities in the capped area and prevent use of impacted groundwater;
- construction of a fence around the capped areas to deter unauthorized access;
- long-term groundwater, surface water, and sediment monitoring;
- possible wetlands mitigation, if adversely impacted; and
- five-year review to evaluate the effectiveness of the remedial measure, including an engineering review of geosynthetic performance under field conditions.

Approximately three wells would be screened in the overburden and one well in the fractured bedrock. The bedrock well would be in the upper 50 feet of bedrock, approximately 300 feet north-northeast of the intersection of Lily Pond Road, Red Village Road and Brown Farm Road. This well would be pumped at approximately 15 gpm. The overburden wells would be fully screened in the Lower Proximal unit. As shown on Figure 3-2, one of the overburden wells would be located approximately 170 feet east-southeast of monitoring well MW 119. A second overburden well would be located approximately 240 feet south-southwest of MW 131. The third overburden well would be located approximately 210 feet east-northeast of monitoring well MW 120. These three would be pumped at approximately 30 to 40 gpm each, for a combined total extraction rate for the MOM system of approximately 115 gpm.

Effectiveness - Alternative 8A

As discussed under Alternative 2, the caps over the SWDA and IWS Areas would effectively address the risk of direct contact with Contaminants of Concern in these areas. The vegetated cap would also minimize stream and sediment impacts due to surface water runoff. Institutional controls would address the risk of groundwater ingestion by preventing impacted groundwater use. Residences within the known area impacted by groundwater contamination either have access to or are currently connected to the Village of Lyndonville's public drinking water supply.

The impermeable caps will also reduce or eliminate rainfall infiltration through source material within the unsaturated zone and resulting impacts to groundwater and adjacent wetlands. Since potential source materials within IWS Areas 1, 2 and 3 are primarily located in the unsaturated zone, the installation of the caps can be expected to significantly reduce the mass-loading of Contaminants of Concern to the groundwater system from these areas. Therefore, there should be a reduction in groundwater concentrations below the presently observed levels even without implementation of groundwater extraction and treatment.

The MOM system would prevent movement of groundwater beyond the known downgradient limits of contamination. Contaminants of Concern which would continue to migrate beyond the SWDA and IWS Areas would be captured by the MOM system. Although they would be reduced due to the effect of the caps and by groundwater flushing, dispersion and natural degradation, groundwater concentrations within the SWDA and IWS Areas and MOM system capture zone could remain above groundwater standards for a long time period. The degree of groundwater quality improvement and timeframe for reduction of levels to remediation goals is not predictable within the foreseeable future.

The MOM system would be designed to contain the downgradient limits of groundwater contamination above the remediation goals as defined by the data collected during the RI. Groundwater contamination may exist beyond the downgradient extraction well locations. Although this contamination would not be contained, once the MOM system is operational, levels of Contaminants of Concern downgradient of the system would decrease via groundwater flushing and natural degradation processes, and eventually reach remediation goals.

The installation and operation of an in-situ soil vapor extraction system within IWS 2 (as described under Alternative 4) would have no impact on the MOM system or length of time it would operate. As discussed in Section 1, the concentrations of Contaminants of Concern in IWS 2 groundwater are 1.5 to 2 orders of magnitude lower than observed in groundwater the vicinity of other IWS Areas, and IWS 2, therefore, does not appear to be a significant source of groundwater contamination. Furthermore, the majority of waste material within IWS 2 is located within the unsaturated zone and therefore, rainfall infiltration and the resulting potential for contaminants to migrate from these materials would effectively be eliminated through the construction of a RCRA cap over this area.

The potential wetlands impacts (both beneficial and adverse) associated with cap construction discussed under Alternative 2 would also apply to Alternative 8A. Water table lowering due to downgradient groundwater extraction is expected to be minimal. Drawdown effects are not expected to propagate through the Distal to the upper portions of the Unnamed Stream, and the lower portions of the Unnamed Stream are separated from the Lower Proximal by 11 to 15 feet. Therefore, impacts to wetlands associated with operation of the groundwater extraction system would be minimal.

The long-term groundwater monitoring plan and five-year site review would be used to measure the effectiveness of the measures implemented under this alternative.

Implementability - Alternative 8A

The technical and administrative implementability considerations discussed previously under other alternatives associated with: design and construction of RCRA caps over the SWDA and IWS Areas; installation and operation of the groundwater and SVE extraction systems; treatment, piping and discharge of treated groundwater to the Passumpsic River; and implementation of institutional controls would also apply to Alternative 8A (depending on whether the MOM system is combined with Alternative 2 or Alternative 4).

Cost - Alternative 8A

Assuming a 30-year operational period and 7 percent interest, the order of magnitude cost for Alternative 8A would be approximately $28,700,000. Cost backup information is included in Appendix C.

Status/Justification - Alternative 8A

Alternative 8A (combined with Alternatives 2 or 4) is retained for further evaluation since it would contain the known downgradient limits of groundwater contamination.

3.2.9 Alternative 8B: Downgradient Groundwater Extraction/Combined with Alternatives 3 or 5

Alternative 8B would supplement Alternative 3 (Containment/Source Control Groundwater Extraction) or Alternative 5 (Containment/In-Situ Vapor Extraction of IWS 2/Source Control Groundwater Extraction) with a MOM system to contain contaminated groundwater that has been detected downgradient of the area encompassed by the SWDA and IWS Areas. Alternative 8B combined with Alternative 7 is not considered further, since Alternative 7 was eliminated from further consideration in Section 3.2.7. Alternative 8B would include the following measures (components that are not also included in Alternatives 3 or 5 are presented in bold type):

- possible temporary relocation of seven mobile homes on the northern side of the SWDA during cap construction activities;
- regrading of the SWDA to achieve appropriate slopes and drainage for the cap;
- possible re-routing of a limited portion of the Unnamed Stream beneath or adjacent to the SWDA cap;

- construction of a composite-barrier (RCRA) cap on the SWDA;
- installation and operation of an active gas collection system and central gas treatment (flaring) system in SWDA and IWS Areas;
- installation of perimeter storm water ditches and a storm water retention pond to manage the surface runoff from the landfill caps;
- construction of composite-barrier (RCRA) caps on IWS 1, 2, and 3;
- design and installation of a soil vapor extraction (SVE) system within IWS 2 (only if combined with Alternative 5);
- long-term (15-year) monitoring and maintenance of the SVE system (only if combined with Alternative 5);
- treatment of extracted air from the SVE system by granular activated carbon (GAC) polishing (only if combined with Alternative 5);
- off-site disposal and/or further treatment or destruction of the SVE system residuals (only if combined with Alternative 5);
- revegetation of the capped areas to control erosion;
- extraction of groundwater to prevent the off-site flow of groundwater that contains concentrations exceeding the remediation goals;
- **extraction of groundwater downgradient of the area encompassing the SWDA and IWS Areas at the known southerly extent of the contaminant plume;**
- treatment of extracted groundwater by air stripping and GAC polishing (or an alternative technology that may be selected during the design phase); this treatment requires a pretreatment step consisting of hydroxide/carbonate precipitation to remove inorganics;
- piping and discharge of treated groundwater to the Passumpsic River (alternatives to discharging treated water to the Passumpsic River will be evaluated during pre-design);
- long-term maintenance, monitoring of the groundwater treatment system;

- off-site disposal and/or further treatment or destruction of treatment residuals;
- institutional controls/deed restrictions to limit intrusive activities in the capped area and prevent use of impacted groundwater;
- construction of a fence around the capped areas to deter unauthorized access;
- long-term groundwater, surface water, and sediment monitoring;
- possible wetlands mitigation, if adversely impacted; and
- five-year review to evaluate the effectiveness of the remedial measure, including engineering evaluation of geosynthetic performance under field conditions.

Approximately five wells would be screened in the overburden and two wells in the fractured bedrock. Both bedrock wells would be located in the upper 50 feet of bedrock. As shown on Figure 3-3, one bedrock well would be located just downgradient of IWS 2, the other bedrock well would be located approximately 300 feet north-northeast of the intersection of Lily Pond Road, Red Village Road and Brown Farm Road. Both bedrock wells would be pumped at approximately 15 gpm. The overburden wells would be fully screened in the Lower Proximal unit. Four overburden wells would be located on a line downgradient of IWS 1 and IWS 2, at spacings of 250 to 280 feet. These wells would be pumped at between 19 gpm and 25 gpm, at a combined rate of approximately 85 gpm. One additional overburden well would be located approximately 150 feet southwest of monitoring well 131. This well would be pumped at approximately 30 gpm. The combined source control and MOM system extraction rate would be approximately 145 gpm.

Effectiveness - Alternative 8B

As with all of the other Alternatives except No Action, the caps alone would minimize the potential for direct contact with Contaminants of Concern in soil and minimize stream and sediment impacts. The risk of groundwater ingestion would be addressed through institutional controls. The caps would also significantly reduce the potential for movement of constituents from the SWDA and IWS Areas to groundwater. Specific effectiveness considerations associated with capping and the source control groundwater extraction system are discussed under Alternatives 2 and 3.

The MOM system would prevent movement of groundwater beyond the known downgradient limits of contamination. Contaminants of Concern within the SWDA and IWS Areas would be contained by the caps and source control groundwater extraction system. The degree of groundwater quality improvement and timeframe for reduction of levels to remediation goals within the SWDA and IWS Areas is not predictable within the foreseeable future. Groundwater downgradient of the source control system would not reduce to remediation goals for approximately 60 years, the same as alternatives that incorporate a source control groundwater extraction system only. As detailed previously, residences within the known area impacted by groundwater contamination either have access to or are currently connected to the Town of Lyndonville's public drinking water supply. Institutional controls would prevent use of groundwater that has been impacted by constituents from the SWDA and IWS Areas. Furthermore, groundwater from the SWDA and IWS Areas has not and is not expected in the future to impact the Passumpsic River.

The MOM system would be designed to contain the downgradient limits of groundwater contamination as defined by data collected by data collected during the RI. Groundwater contamination may exist beyond the downgradient extraction well locations. Although this contamination would not be contained, once the downgradient extraction system is operational levels downgradient of the system would decrease via groundwater flushing and natural degradation processes and eventually reach remediation goals.

The installation and operation of an in-situ soil vapor extraction system within IWS 2 would have no impact on the source control or downgradient extraction systems or the length of time either would operate, since the potential for contaminants to migrate from the unsaturated zone within IWS 2 would be minimized through the construction of a RCRA cap over this area. Furthermore, as previously stated, concentrations of Contaminants of Concern in IWS 2 groundwater are 1.5 to 2 orders of magnitude lower than observed in the groundwater in the vicinity of other IWS Areas, and IWS 2, therefore, does not appear to be a significant source of groundwater contamination even without a cap.

The potential wetlands impacts associated with cap construction, discussed under Alternative 2, would also apply to Alternative 8B. Water table lowering due to downgradient groundwater extraction is expected to be minimal. Drawdown effects are not expected to propagate through the Distal to the upper portions of the Unnamed Stream, and the lower portions of the Unnamed Stream are separated from the lower Proximal by 11 to 15 feet. Therefore, there would not be significant wetlands impacts associated with the operation of extraction wells under Alternative 8B, since the drawdown in wetlands areas that would result from pumping would be minimal (1.5 to 2 feet).

The long-term groundwater monitoring plan and five-year site review would be used to measure the effectiveness of the measures implemented under this alternative.

Implementability - Alternative 8B

The technical and administrative implementability considerations discussed previously associated with design and construction of RCRA caps over the SWDA and IWS Areas; installation and operation of the groundwater and SVE extraction systems; treatment, piping and discharge of treated groundwater from the SWDA and IWS Areas to the Passumpsic River; and implementation of institutional controls would also apply to Alternative 8B.

Cost - Alternative 8B

Assuming a 30-year operational period and 7 percent interest, the order of magnitude cost for Alternative 8B would be approximately $32,000,000. Cost backup information is included in Appendix C.

Status/Justification - Alternative 8B

Alternative 8B (combined with Alternative 3 or 5) is retained for further evaluation since it would contain the known downgradient limits of groundwater contamination.

3.3 SUMMARY OF INITIAL SCREENING OF ALTERNATIVES

The potential alternatives for the Parker Landfill were initially screened against three criteria: effectiveness, implementability, and cost. The following alternatives were retained through the initial screening of alternatives:

Alternative 1: No Action;

Alternative 2: Containment (SWDA, IWS 1, 2 and 3)/No Source Control Groundwater;

Alternative 3: Containment (SWDA, IWS 1, 2 and 3)/Source Control Groundwater;

Alternative 4: Containment (SWDA, IWS 1, 2 and 3)/In-situ Soil Vapor Extraction of IWS 2 Area/No Source Control Groundwater;

Alternative 5: Containment (SWDA, IWS 1, 2 and 3)/In-situ Soil Vapor Extraction of IWS 2 Area/Source Control Groundwater;

Alternative 8: Containment (SWDA, IWS 1 and 3)/Excavation/Treatment/Discharge (may be combined with Alternatives 2 through 5);

Alternative 8A: Downgradient Groundwater Extraction/Combined with Alternatives 2 or 4 (No Source Control Groundwater Extraction System).

Alternative 8B: Downgradient Groundwater Extraction/Combined with Alternatives 3 or 5 (Source Control Groundwater Extraction System).

Section 4 presents the detailed analysis of these alternatives.

4.0 DETAILED EVALUATION OF REMEDIAL ALTERNATIVES

4.1 INTRODUCTION

This section presents the detailed evaluation of remedial alternatives that were retained through the initial screening of alternatives. The detailed analysis consists of an assessment of these individual alternatives against seven of nine criteria. Section 4.2 presents the nine evaluation criteria and the detailed evaluations of alternatives are presented in Section 4.3.

4.2 EVALUATION CRITERIA

The detailed analysis of alternatives includes an assessment of each alternative's feasibility and overall effectiveness, based on the following nine criteria:

1. Overall protection of human health and the environment;
2. Compliance with ARARs;
3. Long-term effectiveness and permanence;
4. Reduction of toxicity, mobility, or volume;
5. Short-term effectiveness;
6. Implementability;
7. Cost;
8. State acceptance; and
9. Community acceptance.

As previously stated, two of the criteria, community acceptance and state acceptance, are evaluated by EPA following EPA's selection of a preferred alternative and preparation of a proposed plan.

These nine criteria can be categorized into three groups, as follows:

1. Threshold criteria, which include overall protection of human health and the environment, and compliance with ARARs. Unless a specific ARAR is waived, each alternative must meet these criteria in order to be eligible for selection;

2. Primary balancing criteria, which include long-term effectiveness and permanence, reduction of toxicity, mobility, or volume through treatment, short-term effectiveness, implementability, and cost; and

3. Modifying criteria, which include state and community acceptance. These modifying criteria are evaluated following the selection of a remedy.

Each of the criteria listed above is discussed in more detail below.

Overall Protection of Human Health and the Environment

Alternatives are assessed to determine whether they can adequately protect human health and the environment, in both the short- and long-term, from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site by eliminating, reducing, or controlling exposures to levels established during development of remediation goals. Overall protection of human health and the environment draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs (EPA, 1990).

Compliance with ARARs

The alternatives are assessed to determine whether they attain applicable or relevant and appropriate requirements under federal environmental laws and state environmental or facility siting laws or provide grounds for invoking a waiver pursuant to section 121(d)(4) of CERCLA and 40 CFR 300.430(f)(1)(ii)(C) (EPA, 1990).

Long-term Effectiveness and Permanence

Alternatives are assessed for the long-term effectiveness and permanence they afford, along with the degree of certainty that the alternative will prove successful. Factors that may be considered, as appropriate, include the following:

- Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities; and

- Adequacy and reliability of controls such as containment systems and institutional controls that are necessary to manage treatment residuals and untreated waste (EPA, 1990).

Reduction of Toxicity, Mobility, or Volume Through Treatment

The degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume shall be assessed, including how treatment is used to address the principal threats posed by the site. Factors that may be considered, as appropriate, include the following:

- The treatment or recycling processes the alternatives employ and materials they will treat;

- The amount of hazardous substances, pollutants, or contaminants that will be destroyed, treated, or recycled;

- The degree of expected reduction in toxicity, mobility, or volume of the waste due to treatment or recycling and the specification of which reduction(s) are occurring;

- The degree to which treatment reduces the inherent hazards posed by principal threats at the site;

- The degree to which the treatment is irreversible; and

- The type and quantity of residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate such hazardous substances and their constituents (EPA, 1990).

Short-term Effectiveness

The short-term impacts of alternatives are assessed considering the following, as appropriate:

- Short-term risks that might be posed to the community during implementation of an alternative;

- Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures;
- Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation; and
- Time until protection is achieved (EPA, 1990).

Implementability

The ease or difficulty of implementing the alternatives is assessed by considering the following types of factors, as appropriate:

- Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, the reliability of the technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy;
- Administrative feasibility, including activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals and permits from other agencies (for off-site actions); and
- Availability of services and materials, including the availability of adequate off-site treatment, storage capacity, and disposal capacity and services; the availability of necessary equipment and specialists, and provisions to ensure any necessary additional resources; the availability of services and materials; and availability of prospective technologies (EPA, 1990).

Cost Analysis

The types of costs that are assessed include the following:

- Capital costs, including both direct and indirect costs;
- Operation and maintenance costs (annual and non-annual); and
- Net present value of capital and O&M costs (EPA, 1990).

The basic procedures used to estimate the costs developed during the initial screening are used to prepare the detailed cost analyses. However, a greater level of accuracy is achieved at this stage. More extensive sources of information and more detailed preliminary design information are used during the detailed evaluation, so that the cost analyses developed for each alternative are accurate within -30 to +50 percent.

The accuracy of each cost estimate developed during the detailed evaluation depends upon the assumptions made with respect to the design, implementation, and operation of an alternative; it further depends on the cost information available. In order to assess the degree of certainty associated with the cost estimates for each alternative, and the impact of changes in underlying assumptions, a cost sensitivity analysis is performed. The sensitivity analysis assesses assumptions associated with individual cost components and the effects they can have on the estimated cost for an alternative. The cost sensitivity analysis varies certain assumptions to determine potential effects on the cost of each alternative. The assumptions varied include factors which possess the ability to cause significant change to total alternative costs with only small changes in values, and factors with a high degree of uncertainty associated with them. These factors include items such as operation and maintenance costs, the volume of treated material, life of the remedial action, size of the treatment system, and the combination of remedial technologies. Low, medium, and high case scenarios are developed for each alternative. A present worth cost, assuming a 30-year operational period, as appropriate, a seven percent interest rate and a zero percent inflation rate, is then prepared for each alternative's low, medium, and high case scenarios.

Appendix C provides detailed back-up associated with each alternative's cost analyses. Present-worth costs are presented assuming a 30-year or 15-year (SVE) operational period, as appropriate, a seven percent interest rate and a zero percent inflation rate.

<u>State Acceptance</u>

Assessment of state concerns may not be completed until comments on the RI/FS are received, but may be discussed, to the extent possible, in the proposed plan issued for public comment (EPA, 1990).

Community Acceptance

This assessment includes determining which components of the alternatives interested persons in the community support, have reservations about, or oppose. This assessment may not be completed until comments on the proposed plan are received (EPA, 1990).

4.3 DETAILED EVALUATION OF ALTERNATIVES

This section presents the detailed evaluation of the alternatives retained through the initial screening. For each alternative, a detailed description, and an assessment of each alternative's feasibility and overall effectiveness, based on the evaluation criteria, is presented. As summarized in Section 3.3, the following alternatives were retained through the initial screening of alternatives:

Alternative 1:	No Action
Alternative 2:	Containment (SWDA, IWS 1, 2, and 3)/No Source Control Groundwater
Alternative 3:	Containment (SWDA, IWS 1, 2, and 3)/Source Control Groundwater
Alternative 4:	Containment (SWDA, IWS 1, 2, and 3)/In-Situ Soil Vapor Extraction Within IWS 2/No Source Control Groundwater
Alternative 5:	Containment (SWDA, IWS 1, 2, and 3)/In-Situ Soil Vapor Extraction Within IWS 2/Source Control Groundwater
Alternative 8:	Downgradient Groundwater Extraction/Treatment/Discharge (may be combined with Alternatives 2 through 5)

Alternative 8A: Downgradient Groundwater Extraction/Combined with Alternatives 2 or 4 (No Source Control Groundwater Extraction System).

Alternative 8B: Downgradient Groundwater Extraction/Combined with Alternatives 3 or 5 (Source Control Groundwater Extraction System).

4.3.1 Alternative 1: No Action

4.3.1.1 Description

Under the No-Action Alternative, no measures would be taken to prevent contact with or minimize infiltration through soil. No measures would be taken to control the migration of groundwater containing Contaminants of Concern from the SWDA and IWS Areas. As discussed previously, EPA has determined that capping of the SWDA and IWS Areas is appropriate as the presumptive remedy. Therefore, Alternative 1 is retained for comparative purposes only, as required by the NCP.

The No-Action Alternative would incorporate the following measure:

- five-year review

4.3.1.2 Detailed Evaluation

This section presents the detailed evaluation of Alternative 1: No Action. Each of the criteria previously identified are assessed.

Overall Protection of Human Health and the Environment - Alternative 1

The evaluation of the Overall Protection of Human Health and the Environment presented below includes consideration of human health protection (with respect to the potential for direct contact with soil and debris and groundwater ingestion), and environmental protection (wetlands effects and groundwater effects).

Baseline risks associated with this alternative have been presented in Section 1.4.1. A summary of the potential risks are presented in Table 1-3 and 1-4, respectively. Under the No-Action Alternative, the potential for direct contact with soil and debris would remain. Natural processes such as biodegradation and dissolution by rain water infiltration and movement to groundwater would reduce the concentrations of Contaminants of Concern in the unsaturated zone. Changes in the volume, toxicity, and mobility of the Contaminants of Concern within the soil would be gradual in nature but difficult to predict.

No measures would be taken to prevent the ingestion of groundwater exceeding groundwater standards. However, the residences downgradient of the SWDA and IWS Areas where Contaminants of Concern have been detected are currently connected, or have the option of being connected, to the Village of Lyndonville's municipal water supply. Similarly, no measures would be implemented to reduce rainwater/snowmelt runoff and erosion from the SWDA and IWS Areas and associated impacts to surface water and sediment within the adjacent stream.

Under Alternative 1, no measures would be implemented to reduce infiltration of rainwater through soil. Infiltration of rain water through unsaturated zone areas could result in the movement of constituents from the soil into the groundwater at levels which would exceed the groundwater remediation goals. Groundwater containing Contaminants of Concern at concentrations exceeding remediation goals would continue to migrate from the SWDA and IWS Areas. Groundwater flushing, dispersion, and natural degradation processes would result in some changes in the concentrations and mass of Contaminants of Concern. However, it is not possible to accurately predict the rate of reduction of concentration that would result from such processes because the total mass in the SWDA and IWS Areas can not be accurately determined.

Therefore, the timeframe for reduction of levels to remediation goals is not predictable within the foreseeable future.

RI data indicate that the Passumpsic River has not been impacted by the groundwater constituents and future impacts are not expected to occur due to the effects of groundwater flushing and natural degradation processes, and the dilution capacity of the Passumpsic River. The volume of groundwater discharge to the Passumpsic River is approximately two orders of magnitude smaller than the low flow discharge of the river. Therefore, mixing will reduce the concentrations of any Contaminants of Concern discharged to the river by two orders of magnitude. In addition, most of the Contaminants of Concern are expected to volatilize rapidly after entering the river, and are, therefore, expected to be non-detectable.

Compliance with ARARs - Alternative 1

Alternative-specific ARARs tables are presented in Tables 4-1 through 4-4. Summary tables for chemical-, action-, and location-specific ARARs are presented in Tables 4-5, 4-6, and 4-7, respectively. Table 4-1 summarizes the chemical-, location- and action-specific ARARs for Alternative 1. This table conveys information on the type of ARAR, environmental medium covered by the ARAR, status of the ARAR, salient requirements of the regulation or guideline, and actions to be taken to attain the ARAR. The following provides a brief overview of the ARARs pertinent to Alternative 1.

Chemical-specific ARARs identified for the Study Area include state groundwater concentration limits for hazardous constituents. State and federal primary (i.e., health-based) drinking water standards, and state groundwater protection standards are also ARARs. Proposed federal MCLs for synthetic organics and inorganics are To Be Considered, because they are not enforceable standards. USEPA Cancer Slope Factors and Reference Doses also are To Be Considered.

Generally, Alternative 1 would not promote compliance with chemical-specific ARARs. Given that the extent of contaminant sources within the Study Area cannot be reliably determined, the degree to which groundwater flushing and natural degradation processes would result in compliance with specific ARARs is difficult to predict with certainty. The groundwater beneath the Study Area is classified by the State of Vermont as Class III, which is suitable for human consumption. Currently this groundwater source is being used as a drinking water supply. However, the residences downgradient of the SWDA and IWS Areas where Contaminants of Concern have been detected are currently, or have the option of being, connected to the Town of Lyndonville's municipal water supply system.

Action-specific ARARs include: substantive requirements of the Vermont Hazardous Waste Regulations that govern hazardous waste Treatment, Storage, and Disposal (TSD) facilities; Vermont Land Use and Development Law (Act 250); and Vermont water quality standards that govern the effects of storm water on receiving waters.

Implementation of Alternative 1 would conform with some of the generalized ARARs governing emergency preparedness and the ability to respond to hazardous waste emergencies at the SWDA and IWS Areas. However, this alternative would not promote conformance with RCRA hazardous waste landfill design and operating requirements, or with Vermont requirements to minimize the potential for releases of hazardous contaminants to the environment. The No Action Alternative does not address the groundwater requirements of Act 250 or protect against adverse effects caused by storm water runoff.

Location-specific ARARs include Vermont Wetland Rules, Federal Fish and Wildlife Coordination Act, Federal Executive Orders on floodplain management and protection of wetlands. In general, Alternative 1 would not satisfy the location-specific ARARs.

<u>Long-Term Effectiveness and Permanence - Alternative 1</u>

The evaluation of Long-term Effectiveness and Permanence presented below considers, as appropriate, the magnitude of residual risk, and adequacy and reliability of controls.

No controls would be implemented to prevent exposure to contaminated soil or ingestion of groundwater containing Contaminants of Concern above the remediation goals. No measures would be taken to prevent further movement of constituents from soil within the SWDA and IWS Areas, or to prevent further migration of groundwater and constituents from the SWDA and

IWS Areas. However, the residences downgradient of the SWDA and IWS Areas where Contaminants of Concern have been detected are currently connected, or have the option of being connected, to the Village of Lyndonville's municipal water supply. Furthermore, RI data indicate that the Passumpsic River has not and will not be adversely impacted by the groundwater constituents.

Reduction of Toxicity, Mobility, or Volume Through Treatment- Alternative 1

The evaluation of Reduction of Toxicity, Mobility, or Volume Through Treatment presented below considers, as appropriate, the treatment processes and materials treated, the amount of hazardous materials destroyed or treated, the degree of expected reduction in TMV through treatment, the degree to which treatment reduces the inherent hazards posed by principal threats at the site, the degree to which treatment is irreversible, and the type and quantity of residuals remaining after treatment.

The No-Action Alternative would not result in a near-term reduction in the toxicity, mobility, or volume of Contaminants of Concern in the soil or groundwater through treatment, since no treatment processes would be employed. Also, no treatment residuals would be generated.

Short-Term Effectiveness - Alternative 1

The evaluation of Short-Term Effectiveness presented below considers, as appropriate, protection of the community and workers during the remedial actions, environmental impacts during the remedial actions, and time until protection is achieved.

There would be minimal short-term risk to the community and workers, or significant adverse environmental impacts, as a result of Alternative 1 implementation, since no action would be taken in the SWDA and IWS Areas or with respect to groundwater. Remedial response objectives would not be met under this alternative, since direct contact with soil and debris that may pose a potential health risk would not be prevented.

As previously stated, groundwater flushing, dispersion and natural degradation processes would result in some changes in the concentrations and mass of Contaminants of Concern. However, it is generally not possible to accurately predict the rate of reduction of concentrations that would result from such processes because the total mass in the SWDA and IWS areas is not known with reasonable accuracy. Therefore, the timeframe for reduction of levels to remediation goals is not predictable within the foreseeable future, and this alternative would not meet groundwater ARARs.

Implementability - Alternative 1

The implementability evaluation presented below considers, as appropriate, the ability to construct and operate technologies, the reliability of technologies, the ability to monitor the effectiveness of the remedy, the availability of services and materials, and the administrative feasibility.

Alternative 1 could be easily implemented since it would only involve performance of five-year reviews.

Cost Analysis - Alternative 1

In accordance with cost analysis procedures previously discussed in Section 4.2, a cost sensitivity analysis was conducted as required by EPA costing guidelines. The cost sensitivity analysis resulted in the preparation of low-, medium- and high cost scenarios. For Alternative 1, the potential cost of the five-year site review was varied.

Estimated costs for the three Alternative 1 cost scenarios (medium, high and low) are presented in the following table (total present-worth costs are rounded to the nearest $10,000). Backup costs for these estimates are presented in Appendix C.

Cost Case Scenarios	Capital Cost	Annual O&M Cost	Present Worth Annual O&M Cost	Present Worth Non-Annual O&M Cost	Total Present Worth
Medium	$0	$0	$0	$43,000	$40,000
High	$0	$0	$0	$54,000	$50,000
Low	$0	$0	$0	$39,000	$40,000

4.3.2 Alternative 2: Containment (SWDA, IWS 1, 2, and 3)/No Source Control Groundwater Extraction

Alternative 2 builds upon Alternative 1 by providing physical containment (capping) of the SWDA and IWS Areas, and administrative controls that would ensure the effectiveness of the remedial action and provide for overall protection of human health and the environment.

4.3.2.1 Description

Alternative 2 involves construction of a cap over the SWDA and IWS Area 1, and separate caps over IWS Areas 2 and 3. Alternative 2 would include the following components:

- possible temporary relocation of seven mobile homes on the northern side of the SWDA during cap construction activities;
- regrading of the SWDA to achieve the appropriate slopes and drainage for the cap;
- possible re-routing of a limited portion of the Unnamed Stream beneath or adjacent to the SWDA cap;
- construction of a composite-barrier (RCRA) cap on the SWDA and IWS 1 Area and separate composite-barrier caps on IWS Areas 2 and 3;

- potential waste reconfiguration to minimize wetlands impacts;

- installation and operation of an active gas collection system and central gas treatment (flaring) systems in SWDA and IWS Areas;

- installation of perimeter storm water ditches and a storm water retention pond to manage the surface runoff from the landfill caps;

- revegetation of the capped areas to control erosion;

- construction of a fence around the capped areas to deter unauthorized access;

- institutional controls/deed restrictions to limit intrusive activities in the capped areas and prevent use of impacted groundwater;

- long-term groundwater, surface water, and sediment monitoring;

- possible wetlands mitigation, if adversely impacted; and

- five-year site reviews to evaluate the effectiveness and adequacy of remedial measures, including engineering review of geosynthetic performance under field conditions.

The following discussions provide additional details regarding components of Alternative 2. Since subsequent alternatives build upon the capping alternative, these descriptions may also apply to other alternatives evaluated in the FS. A detailed evaluation of Alternative 2 is presented in Section 4.3.2.2.

<u>Potential Cap Designs</u>

The caps on the SWDA and IWS Areas would be designed to eliminate the potential for direct human contact with Contaminants of Concern as well as reduce infiltration into the buried solid waste. Reduction of infiltration decreases movement from the buried solid waste and unsaturated zone soils containing Contaminants of Concern, hence is protective of groundwater.

The SWDA received waste from approximately 1972 to 1992, with a large percentage of the filling within the SWDA occurring during the last four years of operation when a thickness of approximately 20 feet of municipal solid waste was placed in the SWDA. The total thickness of the solid waste in the SWDA is approximately 60 to 70 ft (ESE, 1993). As previously stated, the SWDA accepted municipal waste with quantities of hazardous waste. The IWS Areas received principally industrial wastes until the last of these areas was closed in 1983.

As previously described, caps conforming to RCRA Subtitle C requirements would be constructed over the SWDA and the three IWS Areas. Figures 4-1 and 4-2 present schematic top and side slope views of the components of the RCRA Subtitle C cap proposed for all areas. A detailed discussion of the various components included in these cap designs is presented below. It should be noted that the information depicted here represents a conceptual design; the actual cap design and layout would be determined during the final design phase and may vary from the conceptual design.

In 1993, ESE conducted a Borrow Evaluation Study of the Distal soils from the Study Site. Soil characterization and laboratory permeability testing were conducted to evaluate the potential for Distal soils to be used for low permeability barrier material. The results of the study indicated that these soils have a permeability of 10^{-4} cm/sec and, therefore, are not suitable as barrier material (see Appendix E). Based on these results, cap designs for the SWDA and IWS Areas rely on geomembrane barrier materials rather than soil barrier materials.

The caps (Figure 4-1 and 4-2) proposed for the SWDA and IWS Areas have been designed to conform with RCRA Subtitle C Requirements listed in 40 CFR (Subparts F, G and N). The caps have a minimum thickness of three and one-half feet and consist of (from top to bottom):

- six inches of topsoil to support a vegetative cover;
- 30 inches of soil fill to provide a root zone and protection for the underlying components or 18 inches of soil if using sand for drainage;

- nonwoven geotextile filter fabric;
- a geonet/geotextile drainage layer or 12 inches of sand;
- 40 mil VLDPE geomembrane
- low hydraulic conductivity geosynthetic clay liner;
- a base layer of six inches of silt or silty sand.

This system will be utilized for all areas having slopes less than or equal to 5%. For all side slope areas, designed with a 3:1 slope, a minor variation of the base liner design is implemented (See Figure 4-2). From top to bottom, the side slope construction is as follows:

- six inches of top soil to support a vegetative cover;
- 30 inches of soil fill to provide a root zone and protection for underlying components or 18 inches of soil if using sand for the drainage layer;
- nonwoven geotextile filter fabric;
- geonet/geotextile drainage layer or 12 inches of sand;
- textured geomembrane, 40 mil VLDPE or equivalent; and
- a base layer of 12 inches silt or silty sand to establish base grade.

The cap design utilizing soils in lieu of synthetic materials is incorporated in figures and costs.

The geocomposite layer forms the low permeability barrier layer of the cap and consists of a 40 mil very low density polyethylene (VLDPE) geomembrane overlying a geosynthetic clay layer (GCL). GCLs generally consist of high quality granular bentonite sandwiched between or otherwise bonded to geotextile. Alternate GCL designs consist of granular bentonite bonded directly to a geomembrane. GCLs are available with permeabilities of less than 1×10^{-9} centimeters per second (cm/s). Studies have shown that multiple freeze-thaw cycles have little, if any, impact on the GCL permeability (Geoservices, Inc., 1988).

The RCRA caps would allow temporary storage of some precipitation in the drainage layer located above the geocomposite. However, due to the high lateral transmissivity of the geosynthetic or sand based drainage layer, the hydraulic head on the composite barrier layer would be negligible at most times, thereby effectively eliminating the potential for infiltration. Surface infiltration that reaches the drainage layer would be directed off the cap to perimeter drainage swales. Ancillary features would include a storm water management system, perimeter fencing to prevent unauthorized access, and landfill access roads. Drainage swales would be constructed as necessary around the landfill perimeter. The storm water management systems would include perimeter drainage swales and a storm water retention pond designed to handle a 25 year storm event. Design of the retention pond could incorporate modification for post cap vegetation establishment transition to engineered wetlands.

Based on the age and nature of the waste disposed of in the SWDA and IWS Areas, landfill gas management may be necessary. For purposes of the FS evaluation, it is assumed that the landfill gas collection system for the SWDA and IWS Areas would consist of a series of gas collection wells connected via piping to a centrally located flaring station. Due to the proximity of the landfill to residential areas and because methane generation could significantly increase with time due to the fairly recent disposal of municipal waste within the SWDA, gas flaring was selected over passive venting. The gas collection wells would consist of perforated four-inch diameter PVC pipe installed to a depth of approximately 65 feet, the assumed maximum depth of the waste. For the purposes of the conceptual design, gas collection wells were spaced on approximate 75 foot centers over the capped areas. The annular space surrounding the perforated section of the PVC well would be filled with gravel to provide a highly permeable zone for gas flow toward the well. Landfill gas would be drawn to the flaring station through the collection pipe manifold system by a series of electric blowers located in the flaring station. The flaring station would also contain a gas demister, gas condensate traps, and all necessary piping and appurtenances to safely deliver the landfill gas to the flare system.

The cap design described above incorporates design elements that would reduce the detrimental effects of landfill subsidence. First, the preliminary cap design includes a typical top slope of five percent. Surface runoff from the cap can generally be accomplished with slopes of three percent or greater, thus the five percent design slope will provide a margin of safety for proper surface runoff even if differential settlements occur. The cap system will be designed to provide sufficient strength to bridge localized weak areas caused by subsidence of the underlying waste layer. Predesign studies will include investigations to determine the need for additional engineering design for landfill subsidence. Second, the cap design includes the proper operations and maintenance activities (i.e., inspections and repairs) necessary to identify and correct areas of subsidence. Regular inspections and repairs of localized areas of subsidence will prevent ponding on the surface of the cap.

Incorporation of a geomembrane into the design construction virtually eliminates vertical infiltration for both the SWDA and IWS Areas. The combined hydraulic conductivity of the cap system would be governed by the flexible membrane liner (FML), with a permeability of approximately 1×10^{-12} cm/sec. The cap design would allow temporary storage of some precipitation recharge water above the FML. This water would exit the system through drainage and evapotranspiration. Gas collection and flaring dictate that the requirements of the Vermont Air Pollution Control Division be met.

A number of commercially available FMLs have been reported to have experienced no failures when tested under ASTM Method 746 at temperatures to -100F (Koerner, 1990). Studies have shown that multiple freeze-thaw cycles have little, if any, impact on the geocomposite that would be utilized at the SWDA and IWS Areas (Geoservices, Inc., 1988). EPA Region I currently recommends that at least 36 inches of material be placed over the GCL/FML barrier. This design complies with that recommendation. Placement of the liner at least 36 inches below the ground surface eliminates potential damage to the liner from ultraviolet degradation, as well as by frost.

<u>Areal Extent of Cap</u>

Figure 4-3 shows the preliminary conceptual layout and extent of the caps over the SWDA and the IWS Areas. Predesign studies will investigate the potential impact on wetlands and the feasibility of relocating waste materials to minimize these impacts. However, it must be noted that the wetlands potentially affected are not defined as significant and are a result of the precipitation runoff of the site. The need for complete mitigation and replacement will be studied during predesign. Wetland mitigation will be performed as required based on the determined area of impact. Relocation of demolition wastes to the top of the SWDA may allow the cap to be placed outside of all areas designated as wetlands. However, the excavation activities required to relocate this material may severely impact the wetlands and increase risks related to exposure. Furthermore, such excavation may require even more extensive regrading of the site to maintain the maximum 3:1 side slope design constraint. Both IWS 2 and IWS 3 caps would occupy an approximate area of 0.3 acres each. The cap layout for IWS 2 and IWS 3 is based on the approximate waste boundaries determined during the RI (ESE, 1993).

The IWS 1 cap boundary is depicted in Figure 4-3 as being wholly contained within the SWDA cap boundary. During detailed design, the two areas would be "merged" to create cap continuity and a uniform grade on the side slopes. As shown in Figure 4-3, the merged IWS 1/SWDA cap covers an irregularly-shaped area of approximately 19 acres. This layout is based on the SWDA and IWS 1 waste boundaries determined during the RI (ESE, 1993).

Figure 4-4 presents two typical cross sectional views, Sections A and B, of the top surface of the IWS 1/SWDA cap. The locations of Sections A and B are shown on Figure 4-3. Section A is cut along the longer axis of the SWDA. Section B is cut to illustrate the continuity between the two surfaces at IWS 1 to create a uniform side slope. As shown in Figure 4-4, the top slope areas of the SWDA cap will be graded at approximately five percent and side slopes will be graded at three horizontal to one vertical (3:1) or flatter. During final design it will be verified that no side slope area will be graded more steeply than three horizontal to one vertical grades. The typical cross sectional views do not incorporate ancillary components, such as storm water control measures and access road, which would be consolidated into the final cap design. These components would be designed to minimize the impact to wetlands by incorporation into the cap design to the greatest extent possible.

Hydraulic Impact of Cap

RCRA caps over the IWS areas would reduce the amount of water infiltrating through each area from approximately 0.5 gpm to 0.01 gpm. The RCRA cap would reduce the amount of water infiltrating through the SWDA from approximately 13 gpm to approximately 0.26 gpm. These estimates assume an average annual infiltration rate of 18 in/year and conservatively assume a

10^{-7}cm/sec RCRA cap that would be 96% efficient in limiting infiltration. A RCRA cap with a permeability of 10^{-9} cm/sec would eliminate virtually all infiltration.

The groundwater flow rate beneath the SWDA and IWS Areas is estimated to be at least one order of magnitude greater than the (pre-capping) infiltration rate. Therefore, even with the assumption that the entire 14.5 gpm of infiltration is intercepted, the caps would not have any observable effect upon water levels in the Lower Proximal unit.

Institutional Controls

Alternative 2 includes land use controls which would restrict use of the SWDA and IWS Areas and require future developers to use proper health and safety procedures during any work that would penetrate the cover system into the underlying soil. Excavation into the cap and underlying soil during potential future activities, if necessary, would require appropriate repair of the cap and disposal of the excavated soil in accordance with applicable federal and state regulations.

Alternative 2 would also include institutional controls which prohibit the use of untreated groundwater exceeding remediation goals as a drinking water source in the Study Area. The State of Vermont Solid Waste Regulations require maintaining a minimum distance of 1,000 feet between the boundary of the SWDA and drinking water sources. Local regulations could be developed that would prohibit the development of groundwater as a drinking water supply in the SWDA and IWS Areas and impacted downgradient area. All residences within the impacted area are currently or have the option of being connected to the municipal water supply.

Groundwater Monitoring Program

A long-term groundwater monitoring program would be implemented in the Study Area to measure changes in groundwater quality and track contaminant migration. This program would involve the analysis of samples from existing and possibly new wells upgradient, within, and downgradient of the Study Area to monitor groundwater concentrations downgradient of the SWDA and IWS Areas.

It is assumed for purposes of the FS that the groundwater monitoring program would consist of a number of selected well clusters screened at various depths within the overburden and that monitoring wells would also be screened in the bedrock. Groundwater levels and dissolved concentrations of selected Contaminants of Concern would be monitored quarterly for two years and annually thereafter. Data from monitoring wells located within and immediately outside of the SWDA and IWS Areas would be used to evaluate the magnitude and rate of source depletion. Data from downgradient wells would be used to monitor concentration reductions in the aquifer in response to source strength depletion, groundwater flushing, and biodegradation. Based upon the estimated time to achieve clean up presented in subsequent sections of this report, annual monitoring of aquifer conditions would be more than adequate for characterizing meaningful changes in groundwater quality. The inherent variability associated with more frequent monitoring well sampling and laboratory analytical techniques would be larger than the real variability caused by aquifer transport and degradation mechanisms.

Samples would be collected for VOC, SVOC, and EPA Metals analysis. Quarterly reporting of groundwater elevation and analytical data would be conducted for two years. An annual report summarizing site data would be provided each year until concentrations within the groundwater reached remediation goals.

<u>Fence Construction</u>

A range of fence types may be employed to limit or restrict access to the SWDA and IWS Areas. An industrial fence might be used in areas where restricting access is a very high priority. Due to the remote location of the SWDA and IWS Areas, and the observed use of the area by motorized off-road vehicles, an industrial fence would be constructed to prevent access to the SWDA and IWS Areas, as these types of vehicles can cause severe erosional problems due to damage to vegetative cover.

The industrial fence would consist of a 6-foot tall galvanized metal chain link fence with three strands of barbed wire (seven feet total). A sliding or swinging gate, large enough for motor vehicles to pass through, would be installed to allow controlled access to the SWDA and IWS Areas. The height of the gate would be sufficient to restrict access.

Predesign Studies

In order to support the design of Alternative 2, the following predesign studies would need to be completed:

- Project Planning Documents:

  Preparation of a Project Quality Control/Quality Assurance Plan, Health & Safety Plan including air monitoring during cap construction, and Project Management Plan;

- Geotechnical/Subsurface Investigation:

  A geotechnical investigation would be used to define the engineering properties of the SWDA foundation soils. The complete investigation would include a review of existing geotechnical data, installation of soil borings around the SWDA perimeter, laboratory testing of soil samples, and preparation of a summary report. A significant amount of geotechnical data have been collected previously. These data were obtained during installation of soil borings and monitor wells and have included extensive visual characterization of soil samples and some laboratory testing. Engineering properties obtained from the geotechnical investigation would be used to assess SWDA slope stability and predict settlement. This information would also be used to assess the feasibility of waste relocation for minimization of wetlands impact.

- Wetlands:

  The conceptual design of the SWDA cap requires the placement of fill material within the intermittent Unnamed Stream as well as possible rerouting of a limited section of the stream through a culvert. The placement of fill within the stream may alter flooding within the project area. An analysis of hydrological conditions would be performed to evaluate these possible impacts and would include calculation of the maximum flood stage(s) for pre- and post-closure conditions and culvert sizing requirements. Results of the analysis would be used as design criteria for the SWDA closure and wetland management.

- Soil Gas Survey:

  A soil gas survey would be performed to evaluate the quality and quantity of gas production and to evaluate the potential extent of gas migration beyond the landfill boundaries. This information would be used to design the gas collection and treatment system and to determine if there is a need for remediation systems outside of the landfill boundary.

In order to design the gas collection and treatment system, it is necessary to understand both the quantity and quality of the gas produced by the SWDA. This information would be obtained by performing a soil gas survey within the perimeter of the SWDA. During this phase of the survey, gas or air samples would be taken above and below the SWDA surface and analyzed for chemical composition. Subsurface samples would be taken using probes inserted in small borings. Borings would be located at specified locations and depths throughout the SWDA.

The extent of gas migration, if any, beyond the SWDA boundary would be determined by taking soil gas and air samples outside of the SWDA boundary. This information would be used to assess the need for remediation systems in addition to the standard gas collection and treatment as described above. During this investigation, air samples would be collected from discrete locations surrounding the SWDA which may include basements or buildings adjacent to the SWDA property. Soil gas samples may also be analyzed to determine if there is a subsurface pathway for gas migration. Soil gas samples would be taken using probes inserted into small borings. The borings would be located at specified locations surrounding the perimeter of the SWDA.

- Storm Water/Erosion Control Management System Study

  A detailed Storm water/Erosion Control Management System Study would be performed to address details of erosion and sedimentation control, storm water management options and effects of construction operations on storm water, sediments, overall site erosion, and migration of contaminants and exposures. This will be incorporated into the detailed design to provide erosion and sedimentation controls necessary to protect the Unnamed Stream and the Passumpsic River from siltation effects from construction activities.

4.3.2.2 Alternative 2 - Detailed Evaluation

The detailed evaluation of Alternative 2: Containment (SWDA, IWS 1, 2, and 3)/No Source Control Groundwater is presented below.

Overall Protection of Human Health and the Environment - Alternative 2

The evaluation of the Overall Protection of Human Health and the Environment presented below includes consideration of human health protection (with respect to the potential for direct contact with soil and debris and groundwater ingestion), and environmental protection (wetlands effects and groundwater effects).

Capping of the SWDA and IWS Areas would eliminate the potential for direct human contact with soil and eliminate erosion and sedimentation impacts currently existing. There would be some risk of worker exposure during site grading and cap construction, requiring compliance with appropriate health and safety precautions and erosion and sedimentation control methods. Once the cap is constructed, deed restrictions would limit intrusive activities within the boundary of the capped SWDA and IWS Areas. Excavation into the cap and underlying soil, if necessary, during potential future activities would require appropriate repair of the cap and disposal of the excavated soil in accordance with applicable federal and state regulations, as well as appropriate health and safety considerations. Routine operation and maintenance procedures, as well as five year review activities, will include an evaluation of the performance of geosynthetics under field conditions.

As stated previously in the evaluation of Alternative 1, the residences downgradient of the SWDA and IWS Areas where Contaminants of Concern have been detected are currently, or have the option of being, connected to the Village of Lyndonville's municipal water supply system. By implementation of deed restrictions and other institutional controls limiting the potential for development or use of groundwater in this area, the risk of exposure due to ingestion of groundwater would be minimized.

Since potential source materials within IWS 1, 2, and 3 are primarily located in the unsaturated zone, the installation of impermeable caps over these areas would significantly reduce the mass-loading of Contaminants of Concern to the groundwater from these areas and therefore result in an improvement in downgradient groundwater quality. Concentrations could remain greater than the remediation goals, but would be reduced due to the effect of the caps and by groundwater flushing, dispersion and natural degradation. Based on site history and RI data, there may be DNAPL within the saturated zone within the area encompassed by the SWDA and IWS Areas. The location and quantity of DNAPL, which would serve as a continuing source of Contaminants of Concern to groundwater, cannot be reliably determined. Therefore, the degree of groundwater quality improvement and timeframe for reduction of levels to remediation goals is not predictable within the foreseeable future.

The presence of caps over the SWDA and IWS Areas would reduce, or eliminate, the infiltration of rainwater and, in turn, the development and migration of leachate into adjacent wetlands. Surface runoff of rain or snowmelt would also remain uncontaminated as it would migrate through or over clean, vegetated fill. Maintained cap surfaces would minimize site erosion and discharge of sediment to the wetlands, Unnamed Stream or Passumpsic River. Therefore, impacts to surface water and sediment in the adjacent wetlands would be minimized.

The wetlands located south and southwest of the landfill are generally developed around exfiltrating portions of the Unnamed Stream. East of the SWDA and northeast of IWS 2, the wetlands are partially a result of the high water table in the Upper Proximal and Distal units. The small reduction of groundwater flow by capping is not expected to affect those wetlands. Wetlands would be impacted in the northern portion of the site where a portion of the Unnamed Stream may be routed through a culvert beneath the cap or be relocated adjacent to the cap. However, the primary function of the existing wetland in the area is to provide a conduit for surface water drainage from the SWDA, to stabilize sediments, to retain nutrients/toxicants from the source, and to provide support of wildlife diversity/abundance. The design of the caps for the SWDA and IWS Areas would include a storm water system including a detention pond for erosion and sedimentation control during construction which could be constructed into engineered wetlands after vegetation has been established on the landfill cap. Impacted wetlands soils could be stockpiled from excavated areas for re-establishment as part of the closure design. Wetland-dependent species vegetation could be incorporated into the engineered wetlands to support birds and other wildlife. Construction design would incorporate measures to minimize impacts to the wetlands, including careful staging area placement, the use of erosion and sedimentation control devices, construction scheduling and site coordination. Alternative methods of wetlands mitigation would be reviewed and incorporated as necessary to provide adequate mitigation.

Details of mitigation design are not appropriate at this time, as the extent of wetlands impacted has not been fully determined.

Contaminants of Concern from the SWDA and IWS Areas have not impacted, nor are expected in the future to impact, the Passumpsic River.

Compliance with ARARs - Alternative 2

Table 4-2 summarizes the ARARs for Alternative 2. ARARs compliance for Alternative 2 is similar to that for Alternative 1, with the following significant exceptions:

- The gas collection systems will be evaluated to determine if emissions of criteria pollutants and/or hazardous air pollutants will require abatement through application of control technologies.

- Groundwater quality would improve due to the presence of caps on SWDA and IWS Areas. However, groundwater ARARs would not be met in the foreseeable future.

- Alternative 2 complies with the standards for closure and post-closure of hazardous waste landfills.

- Installation of a composite barrier cap on the IWS and SWDA Areas would retard migration of hazardous constituents, and thereby conform with Vermont Land Use and Development Law (Act 250) to minimize the potential for releases of hazardous constituents.

- Alternative 2 complies with substantive requirements of RCRA Subtitle C, the groundwater monitoring program described in RCRA Criteria for Municipal Solid Waste Landfills, and RCRA requirements for listed and characteristic hazardous waste.

- As delineated on the National Wetlands Inventory Map, only wetland habitat immediately adjacent to the Passumpsic River, and none of the wetlands associated with the Unnamed Stream are designated as "significant" and subject to the Vermont Wetland Rules. There is currently no impact, from the landfill, on significant wetlands. Alternative 2 will continue to protect significant wetlands by improving water quality and reducing impacts of surface runoff of rain or snowmelt from the SWDA and IWS Areas.

- Alternative 2 minimizes adverse effects to wetlands in accordance with substantive requirements of Federal regulations promulgated under the Clean Water Act, Fish and Wildlife Coordination Act and Executive Order 11990 Protection of Wetlands. As part of this effort, access roads required for remedial action will avoid wetlands where possible, and the completed SWDA access road will be built as part of the landfill cap. Following completion of cap construction, wetland mitigation will be done, as necessary, to restore disturbed areas. Although no regulated sensitive habitats have been identified in the SWDA and IWS Areas, care will be taken to minimize adverse impacts to existing wetlands.

Long-Term Effectiveness and Permanence - Alternative 2

The evaluation of Long-term Effectiveness and Permanence presented below considers, as appropriate, the magnitude of residual risk, and adequacy and reliability of controls.

The installation of caps would prevent contact with Contaminants of Concern that may pose a potential risk to human health. Deed restrictions and the construction of a fence to restrict access would further reduce the likelihood of direct exposure to soil and debris that may pose a health risk. Institutional controls preventing groundwater use would address the risk of exposure to impacted groundwater in the short- and long-term.

Rainwater infiltration and subsequent movement of Contaminants of Concern from soil and debris in the unsaturated zone would be eliminated beneath the RCRA caps. Contaminant leaching and erosion of contaminated soils would also be eliminated. Since the majority of potential source materials in the SWDA and IWS Areas are located above the water table, the caps would significantly reduce the mass-loading of Contaminants of Concern to the groundwater system from these areas, resulting in groundwater quality improvement within and downgradient of the SWDA and IWS Areas.

Although capping of the SWDA and IWS Areas and groundwater flushing, dispersion and natural degradation processes would improve groundwater quality, levels in groundwater may not reduce to drinking water standards until sources that may be located in the saturated zone are depleted. It is not possible to accurately predict the rate of reduction of concentration that would result from capping, groundwater flushing, dispersion and natural degradation processes, because the total mass of sources potentially present within the saturated zone in the SWDA and IWS Areas can not be accurately determined. Therefore, the timeframe for reduction to remediation goals is not predictable within the foreseeable future.

Contaminants of Concern are expected to continue to migrate towards and discharge to the Passumpsic River. However, the concentrations of Contaminants of Concern in the river are expected to continue to be below detection limits. The volume of groundwater discharge to the Passumpsic River is approximately two orders of magnitude smaller than the low flow of the river. Therefore, mixing would reduce the concentrations of any Contaminants of Concern discharged to the river by two orders of magnitude. In addition, most of the Contaminants of Concern are expected to volatilize rapidly after entering the river, and are therefore, expected to be non-detectable.

The performance of a cap system is proven, in general, to be excellent. Due to the depth and age of the fill material within the SWDA, long-term (post-closure) settlement could adversely impact landfill covers. However, over time, settlement processes approach equilibrium and decrease in magnitude and rate, and as previously discussed, the design of the cap would incorporate design elements that would reduce the potential detrimental effects of landfill subsidence. Routine operation and maintenance procedures will include an evaluation of the performance of geosynthetics under field conditions.

The long-term effectiveness of a cap would depend upon the potential for penetration of the cover system which could result in the potential for human contact with contaminated soil and allow rainwater percolation through the soil. However, the use of land use restrictions would prevent future activities that penetrate the cap and require measures which ensure that the integrity of the cap is maintained. In addition, monitoring would include visual inspection and proper repair of any cap failures. Limiting site access through fencing capped areas would also minimize the potential for liner punctures.

Reduction of Toxicity, Mobility, or Volume - Alternative 2

The evaluation of Reduction of Toxicity, Mobility, or Volume presented below considers, as appropriate, the treatment processes and materials treated, the amount of hazardous materials destroyed or treated, the degree of expected reduction in TMV through treatment, the degree to which treatment reduces the inherent hazards posed by principal threats at the site, the degree to which treatment is irreversible, and the type and quantity of residuals remaining after treatment.

Under Alternative 2, no treatment processes would be employed. Therefore, there would be no reduction of TMV through treatment, and no treatment residuals would be generated.

Short-Term Effectiveness - Alternative 2

The evaluation of Short-Term Effectiveness presented below considers, as appropriate, protection of the community and workers during the remedial actions, environmental impacts during the remedial actions, and time until protection is achieved.

Special precautions including air quality monitoring would be necessary during site preparation and cap construction activities to minimize potential exposure and safety risks, since a residential area is located adjacent to the SWDA and IWS Areas. Access to the construction area would need to be restricted during the construction period. There would be an increase in truck traffic and associated noise, and an increase in dust levels associated with site preparation and cap construction. Based on the conceptual cap designs, approximately seven mobile homes from the adjacent trailer park would require temporary relocation during the construction period. Dust control techniques such as wetting unvegetated soils and haul roads, minimizing the working area of exposed soils, and covering soil stockpiles would be employed. Erosion control methods such as silt fencing and stabilized construction entrances will be utilized to minimize silt runoff from construction operations undertaken. Perimeter air monitoring for VOC emissions and particulate matter would be conducted near residential areas during construction activities.

The implementation of Alternative 2 could be accomplished at minimal risk to construction workers. During regrading of the existing SWDA and IWS Areas, including any relocation of demolition debris, there would be a potential risk of exposure due to contact with and potential inhalation of particulates. Therefore, during these activities, protective clothing would be utilized and particulate respiratory equipment would be donned as necessary, based on air monitoring results. Following the installation of the bottom layer of the cap, safety considerations for worker exposure to soil containing concentrations of Contaminants of Concern greater than the clean up or health-based standards would be minor, and the construction of the remaining cover system would likely require minimal health and safety precautions. Safety concerns would involve the potential for normal construction-related injuries.

There would be no significant adverse environmental impacts from cap construction, although potential siltation of the Unnamed Stream and ultimately the Passumpsic River during construction would require protective measures including the use of erosion and sedimentation control methods such as silt fencing, stabilized construction entrances, and rock filters. Material stockpile and staging areas will be carefully located to minimize environmental impacts to the site and the Unnamed Stream. Waste relocation operations associated with the demolition, if implemented, would increase risks to the environment and would also be addressed as above. With the exception of possible waste relocation along the perimeter of the SWDA debris, intrusive activities would not be performed under this alternative. Therefore, the risk of remobilizing contaminants within the subsurface and increasing the extent of contamination would be minimized under Alternative 2. As previously stated, a portion of the Unnamed Stream along the northeastern portion of the SWDA may be routed through a culvert or relocated adjacent to the cap due to cap construction. The design of the caps for the SWDA and

IWS Areas would include a storm water system including a detention pond which could be incorporated into engineered wetlands.

The beneficial results of the cap would occur immediately following installation. The cap would prevent direct contact with Contaminants of Concern in soil immediately upon installation of the bottom layer. Infiltration of precipitation into the soil, and impacts to adjacent wetlands from surface runoff would be prevented immediately upon construction of the cap.

There would be no short-term attainment of groundwater remediation goals under this or any other alternative. However, short-term protectiveness would be accomplished through institutional controls. As previously stated, the residences downgradient of the SWDA and IWS Areas where Contaminants of Concern have been detected are currently served by the Town of Lyndonville's municipal water supply or have the ability to connect to the system. Upon implementation of institutional controls preventing the use of impacted groundwater, the risk of exposure due to ingestion of groundwater would be minimized. Continued enforcement of these controls would effectively address the health and environmental risk concerns by preventing ingestion of groundwater containing constituents above remediation goals. In addition, the long-term monitoring program would track the extent of downgradient contamination.

The time required to implement Alternative 2 is estimated in the following table.

TASK	MONTHS
Pre-Design Activities	3
Design (Preliminary through Final)	9
Equipment/Material/Contractor Procurement	2
Site Preparation	2
Construction of Cap	9
Vegetation of Cap	3
Total Estimated Implementation Time (Calendar)	24

Schedule development at this phase of the project must be performed conservatively, and is subject to change based on design parameters and site conditions encountered including climate impacts on field/construction activities. It is possible that this schedule will expand or shrink as more detailed design activities are undertaken.

<u>Implementability - Alternative 2</u>

The implementability evaluation presented below considers, as appropriate, the ability to construct and operate technologies, the reliability of technologies, the ability to monitor the effectiveness of the remedy, the availability of services and materials, and the administrative feasibility.

The measures included under Alternative 2 would be reliable, and could be implemented. All of the components are well developed and commercially available. RCRA caps have been successfully installed at many similar sites, and experienced subcontractors are available. Some specialized construction skills and equipment would be needed; however, qualified vendors and remediation subcontractors are available to complete the tasks included in Alternative 2.

Temporary relocation of the affected mobile homes could be easily completed using standard construction procedures. An available area provided by the current landowner would allow relocation of mobile homes to another site during cap construction, and residents can maintain use of their residences. The cap design would address the required separation distance between the high-tension utility lines traversing the SWDA and the top of the cap.

Caps have been demonstrated to be reliable at other sites. Periodic inspections of the caps to ensure that they continue to effectively prevent direct contact with soil and debris containing Contaminants of Concern above remediation goals would be necessary and could be easily implemented. The materials that comprise each of the evaluated cap designs are available in the vicinity of the SWDA and IWS Areas, or could be delivered within a reasonable time frame.

Groundwater monitoring would be easy to implement since it is ongoing and could be continued. The services and materials necessary to install additional monitoring wells, if necessary, and construct an industrial fence are also readily available.

Institutional controls preventing the use of groundwater also would be implementable. As previously discussed, a public water supply is available to the impacted area. However, implementation of the controls would require the cooperation of landowners, the Town, and the State of Vermont.

Cost Analysis - Alternative 2

In accordance with cost analysis procedures previously discussed in Section 4.2, a cost sensitivity analysis was conducted as required by EPA costing guidelines. The cost sensitivity analysis resulted in the preparation of low-, medium- and high-case cost scenarios for both the capital and operation and maintenance costs of each alternative. Primary capital, operation and maintenance assumptions, specifically pertaining to Alternative 2, that were varied include:

- the amount of engineering time required for cap design, construction and installation;
- the amount of gas condensate generated for disposal;
- the specific components of cap design;
- the frequency of and the number of wells to be monitored as part of the monitoring program;
- the amount of wetlands restoration which will be required;
- the amount and cost of equipment replacement; and
- the cost of associated engineering requirements.

These assumptions were also varied for other alternatives involving containment (Alternatives 3, 4, 5, 8A, and 8B).

Estimated costs (total present worth costs are rounded to the nearest $100,000) for the three Alternative 2 cost scenarios (medium, high, and low) are presented in the following table. Specific numbers utilized in the cost assumptions and factors in the three cost scenarios for Alternative 2 are presented on the detailed cost assumptions list in Appendix C. Backup calculations are also presented in Appendix C.

Cost Case Scenarios	Capital Cost	Annual O&M Cost	Present Worth Annual O&M Cost	Present Worth Non-annual O&M Cost	Total Present Worth
Medium	$11,600,000	$150,000	$1,860,000	$150,000	$13,600,000
High	$16,000,000	$250,000	$3,100,000	$200,000	$19,300,000
Low	$8,400,000	$150,000	$1,860,000	$150,000	$10,400,000

4.3.3 Alternative 3: Containment (SWDA, IWS 1, 2, and 3)/Source Control Groundwater Extraction/Treatment/Discharge

Alternative 3 builds upon Alternative 2 by including a source control groundwater extraction system. Groundwater migration beyond the area encompassed by the SWDA and IWS Areas would be prevented through installation and operation of extraction wells. Treatment of groundwater would be performed prior to discharge to the Passumpsic River.

4.3.3.1 Description

As previously discussed, Alternative 3 involves installation of a cap combined with extraction and treatment of groundwater. Specifically, Alternative 3 involves the following components (measures not included under Alternative 2 are denoted in bold)

- possible temporary relocation of seven mobile homes on the northern side of the SWDA during cap construction activities;

- regrading of the SWDA to achieve appropriate slopes and drainage for the cap;

- possible re-routing of a limited portion of the Unnamed Stream beneath or adjacent to the SWDA cap;

- construction of a composite-barrier (RCRA) cap on the SWDA and IWS 1 Area and separate composite-barrier caps on IWS Areas 2 and 3;

- potential waste reconfiguration to minimize wetlands impacts;

- installation and operation of an active gas collection system and central gas treatment (flaring) systems in SWDA and IWS Areas;

- installation of perimeter storm water ditches and a storm water retention pond to manage the surface runoff from the caps;

- revegetation of the capped areas to control erosion;

- construction of a fence around the capped areas to deter unauthorized access;

- possible wetlands mitigation, if adversely impacted;

- **extraction of groundwater to prevent the off-site flow of groundwater that contains concentrations exceeding the remediation goals;**

- **groundwater treatment by air stripping and GAC polishing (an alternate technology may be selected during the design phase); this treatment requires a pretreatment step consisting of inorganics removal using carbonate/hydroxide precipitation;**

- **discharge of treated groundwater to the Passumpsic River. Groundwater would be treated to obtain the levels necessary to comply with the substantive requirements of the NPDES program requirements (alternatives to discharging treated water to the Passumpsic River will be evaluated during pre-design);**

- **long-term maintenance, monitoring of the groundwater treatment system;**

- **off-site disposal and/or further treatment or destruction of treatment residuals;**

- institutional controls/deed restrictions to limit intrusive activities in the capped areas and prevent use of impacted groundwater containing constituents above remediation goals;

- long-term groundwater, surface water, and sediment monitoring; and

- a five-year site review to evaluate the effectiveness and adequacy of remedial measures, including engineering review of geosynthetic performance under field conditions.

The detailed evaluation of this alternative considers the impact of combining capping of the SWDA and IWS Areas with groundwater extraction, treatment, and discharge. The following discussion provides additional detail regarding the measures that would be implemented under Alternative 3. These descriptions may also apply to other groundwater extraction alternatives.

Groundwater Recovery

Approximately four wells would be required in the overburden and one well in the fractured bedrock to achieve hydraulic control of the area encompassed by the SWDA and IWS Areas containing groundwater constituents greater than the remediation goals (Figure 4-5). In order to ensure that Contaminants of Concern at any elevation in the Lower Proximal unit would be captured, the overburden wells would be screened through the full saturated thickness of that unit. Contaminants of Concern leave the Upper Proximal and enter the Lower Proximal in the vicinity of IWS 2 through the Esker Delta deposit, which provides an effective hydraulic connection between the two units. These Contaminants of Concern would therefore, also be effectively captured by the groundwater extraction system. Based upon the capture-zone analyses presented in Appendix F, the overburden wells would be located on a line downgradient of IWS 1 and IWS 2, at spacings of 250 to 280 feet (Figure 4-6). These wells would be pumped at between 19 gpm and 25 gpm, or at a combined rate of approximately 85 gpm. The bedrock well would be located in the upper 50 feet of bedrock, just downgradient of IWS 2. Based upon the pump-test conducted in bedrock and the capture-zone analyses presented in Appendix F, a pumping rate of approximately 15 gpm would be necessary for hydraulic control in the fractured bedrock. Therefore, a total groundwater extraction rate of approximately 100 gpm is estimated.

Groundwater Concentrations

For the planning purposes of the FS, the concentrations of constituents in the extracted groundwater were estimated differently for VOC and inorganics. These calculations are presented in Appendix B. The groundwater concentrations for the organic compounds were estimated using an adaptation of the mixed linear reservoir or "batch flush" model (EPA, 1988b; 1988c). As noted in the model documentation, the methodology results in log/linear function of concentration and time. The function is dependent upon the starting concentrations and the soil-water partitioning coefficients (K_d) of the organic compounds. The starting concentrations were estimated by using the average concentration of compounds observed in the monitoring wells located within the predicted capture zone of each extraction well. The K_d values were calculated from published K_{ow} or K_{oc} values for each compound detected. Average groundwater inorganics concentrations for Alternative 3 were determined from the pump test analytical data. Table 4-8 summarizes the average organic concentrations used to evaluate the treatment technologies.

Groundwater Treatment

Above-ground treatment of extracted groundwater would likely involve the following processing steps which incorporate the representative process options selected in the preliminary screening (Section 2):

1. Consolidation of contaminated groundwater from the recovery wells in an equalization tank to produce a uniform influent to the treatment system;

2. Due to the potential for inorganics to adversely impact the VOC removal system, pretreatment to remove inorganics by hydroxide/carbonate precipitation; and

3. Treatment of the groundwater by air stripping with a GAC polish.

The general configuration of the treatment systems are shown in schematic form in Figure 4-7. Each of the above systems and anticipated influent concentrations are described below and in Appendix B.

Inorganics Pretreatment

Pretreatment to reduce the concentration of metals, hardness and other inorganics in extracted groundwater would be necessary to prevent fouling, clogging and inhibition of the organics removal treatment units. The high level of hardness in the groundwater (above 1,200 ppm) seen during the pumping test would lead to the increased potential for precipitation and build up on water treatment equipment and would negatively effect organic removal by activated carbon, stripping, or biological treatment. Elevated iron levels (>70 ppm) in the groundwater would inhibit many forms of treatment, increase clogging of equipment and systems, and provide a media for iron bacteria growth.

Inorganics may be removed from aqueous streams by a variety of methods (see Section 2). For the preliminary planning purposes of this FS, hydroxide/carbonate precipitation, coupled with gravity settling to remove the precipitated solids and final filtration, is carried through the detailed evaluation. The treatment method includes hardness removal to improve the efficiencies of the organic removal system following the inorganics treatment. Initial calculations of the potential discharge limit for some inorganics based solely on available attenuation of the Passumpsic River showed values which may be difficult to technically attain. Pre-design studies, such as treatability and bioassay testing, may show that the treatment method determined to be most effective and appropriate does not need to meet the originally calculated discharge limits.

Therefore, a limit waiver or other accommodation would need to be obtained from the Vermont NPDES program.

Precipitated metals, hardness, and other inorganics would be flocculated by the addition of polymers, and settled in a clarifier, accumulating as sludge. Following sedimentation the clarified stream would have residual fine particles removed by granular media filtration, using materials such as graded sand and crushed anthracite coal in layers. This filtration may be accomplished in gravity tanks or in packed pressure vessels. Specific location of the filters within the process schematic will vary depending on the final determination of selected filter type.

The summary table of the inorganics treatment system components and size estimates is included in Appendix C. The following approximate values provide a summary description of the scale of the inorganics pretreatment equipment which would be used to treat extracted groundwater under Alternative 3:

- equalization tank: 12,000 gallons;
- flocculation tank: 2,000 gallons;
- clarifier: 18,000 gallons, 16 feet diameter
- pressure filters (3), 3 feet diameter each; and
- backwash pump rate; 100 gpm;
- chemical storage tanks w/metering pumps: 2 at 250 gallons; and
- sludge thickening and dewatering equipment.

Air Stripping

Air stripping is a commonly accepted method to remove organic contaminants from a wastewater or groundwater stream. Air stripping devices can be either air through water or water through air in design. Air through water devices force air through a volume of water within a vessel, and are more commonly found at wastewater treatment facilities. More frequently used for groundwater treatment is a water through air system, specifically, a countercurrent packed tower. In this system, the contaminated water is passed through a packed column, with a counter flow air stream flowing from the bottom of the tower to the top. The system creates water droplets or a film over the glass, ceramic, or plastic media. The intimate contact between the air and the water in the tower causes a mass transfer process by which volatile contaminants are transferred to the gas.

The following discussion describes a possible approach for the design of a treatment system utilizing air stripping. The actual design selected may vary from the discussion presented, and would depend on further analysis which would be conducted during the design stage. Pilot testing and treatability studies may be necessary for developing actual design criteria.

Water from the inorganics pretreatment system filter would be pumped to a manifold at the top of the countercurrent packed tower. Ambient air would be forced through the bottom of the tower and discharged from the top of the system, where it would be collected, if necessary, for discharge through vapor phase activated carbon to prevent release of unacceptable levels of organics to the atmosphere.

Typical loadings to air strippers are 10-20 gallons per minute per square foot. Assuming a 100 gpm groundwater flow rate, the system air stripper would consist of one tower approximately three feet in diameter and 17.5 feet tall. The tower would be designed with both packing and sump access ports for future maintenance. Efficiencies are improved with warmer temperatures; therefore, because of local climate, the entire treatment system would be protected in a heated building. Low profile air strippers may be appropriate and can reduce building height requirements and therefore the associated costs. Predesign studies would incorporate review of alternative equipment.

Carbon Adsorption

Activated carbon adsorption is a physical process in which an organic constituent is transferred from either the aqueous or vapor phase to the surface of a solid carbon particle, where it accumulates for subsequent extraction or destruction. Activated carbon selectively adsorbs constituents by a surface attraction phenomenon in which they are attracted to the internal pores of the carbon particles.

The following discussion describes a possible approach for the design of the treatment system utilizing GAC. The actual design selected may differ from that presented and would depend upon further analysis that would be conducted during the design phase. With this system, groundwater would be pumped to the equalization tank to allow homogenization. It would then be pumped through a inorganics pretreatment system including precipitation, settling, and filtration. Following the filtration system, the groundwater would enter the air stripping unit. Groundwater from the air stripper would flow to the liquid activated carbon system, while the gaseous discharge flows to the vapor phase activated carbon, if necessary, to prevent release of unacceptable levels of organics to the atmosphere. Predesign studies and detailed design may indicate that vapor-phase carbon may not be required, and vapor-phase carbon systems will become less necessary as the life of the treatment system continues. A conservative approach for both GAC portions of the treatment system would provide for multiple carbon units in series. This would allow the first bed to be run to exhaustion before breakthrough is observed on the second bed and is the most economical way of running a GAC system. This would provide optimal flexibility in terms of maintenance and replacement of units while maintaining on-line capacity.

Based on the above system approach, an estimated flow rate of 70 to 130 gpm and an Empty Bed Contact Time (EBCT) of approximately 15 minutes per liquid carbon unit, the aqueous GAC system would consist of three carbon canisters operating in series (allowing for 20 percent bed expansion during backwash) which are approximately eight feet tall, six feet in diameter, and each contain approximately 5,000 pounds of granular activated carbon (depending on the specific gravity of the carbon used). The vapor-phase GAC system would consist of one vapor-phase carbon unit with two beds, each three feet deep, and each bed would contain approximately 6,000 pounds of carbon. Manufacturer's recommendations for equipment sizing was utilized based on anticipated flow rates and contaminant loadings. However, as there are many standard units on the market and there is significant flexibility in the design parameters discussed previously, ready-made carbon units which would approximate Study Area requirements would be used.

Location of Treatment Facility

A location for the treatment facility would be selected that takes into account access to the system, as well as space requirements. It is assumed, for the preliminary planning purposes of this FS, that treatment equipment and associated buildings would be located near the existing Parker Landfill entrance, due to the anticipated extraction well locations, availability of space and accessibility of electrical power.

Treated Groundwater Discharge

Preliminary discussions with the Vermont Department of Environmental Conservation indicate that discharge of treated groundwater to either the Unnamed Stream or the Passumpsic River would be acceptable as long as water quality standards are met. The discharge would be required to meet the substantive requirements of the Vermont National Pollution Discharge Elimination System (NPDES) discharge program. The program would require initial and on-going monitoring of the treatment system for compliance with the limitations which will be determined during the review process. For the preliminary planning purposes of this FS, it was assumed that the EPA Ambient Water Quality Criteria would be applied with a 7 day, 10 year critical flow rate in the receiving stream. Discharge to the Unnamed Stream was then determined to be inappropriate as it may be technically difficult to achieve the limits which would be imposed. Actual bioassay toxicity testing which will be performed during the detailed design phase will provide additional information for determination of the site specific discharge limitations. Additional review of alternative discharge locations and options will be performed during the detailed design phase. This will include but not be limited to comparisons of treatability quality to discharge requirements for the Unnamed Stream, the Passumpsic River, and through an engineered wetlands created by this discharge to replace wetlands potentially impacted by the cap construction.

It is anticipated that treated groundwater will be discharged to the Passumpsic River by means of either a gravity discharge line or a pumped forced main. Force main construction is more likely due to both the distance (approximately one-half mile) to the receiving stream from the treatment facility's location and the rail and road crossings which would be entailed.

Institutional Controls, Access Restrictions, Groundwater Monitoring Program, Five-Year Review

The institutional controls, access restrictions (fencing), and monitoring program performed under Alternative 3 would be similar to those described for Alternatives 1 and 2, although the monitoring program may be modified to confirm the capture zones of the extraction wells and include the treatment system permit monitoring requirements. Additional monitoring wells may be installed to allow better confirmation of capture zones and effectiveness of remedial measures. A five-year review would be performed to confirm the effectiveness of the remedial measures implemented as part of Alternative 3.

Predesign Studies

The predesign studies for the cap described under Alternative 2 would be required for Alternative 3 as well. Additional predesign studies that would be necessary for Alternative 3 include the following:

- Pilot treatability testing for various treatment methods and bioassay analysis of the treated groundwater would be performed to determine the most appropriate and effective treatment technology. Sampling of the treated groundwater may allow the elimination of some system components. Sludge analysis would be conducted to determine acceptable disposal methods;

- A pipeline survey would be performed along the potential routes of the outfall line to the Passumpsic River, including soil borings to determine acceptable construction techniques;

- A geotechnical study of the proposed treatment system location would be performed, including borehole installation and analytical testing for bearing and capacity, to determine the best location for the treatment facility and evaluate construction/foundation requirements; and

- A groundwater discharge/watershed study would be conducted to evaluate discharge options of treated groundwater. This would include preliminary design modeling of a reinjection system, discharge through engineered wetlands and development of NPDES discharge program coordination for outfall to the Passumpsic River or other receiving stream.

4.3.3.2 Alternative 3 - Detailed Evaluation

The following discussion presents the detailed evaluation for Alternative 3: Containment (SWDA, IWS 1, 2, and 3)/Source Control Groundwater Extraction/Treatment/Discharge.

Overall Protection of Human Health and the Environment - Alternative 3

The evaluation of the Overall Protection of Human Health and the Environment presented below includes consideration of human health protection (with respect to the potential for direct contact with soil and debris and groundwater ingestion), and environmental protection (wetlands effects and groundwater effects).

Installation of the caps and implementation of deed restrictions to limit activities on the capped areas would minimize the potential for direct contact with soil and debris and eliminate erosion and sedimentation impacts currently existing. The short-term risks associated with construction would be similar to those described under Alternative 2. As stated previously, the residences downgradient of the SWDA and IWS Areas, where Contaminants of Concern have been detected, are currently, or have the option of being, connected to the Village of Lyndonville's municipal water supply. Upon implementation of deed restrictions and other institutional controls limiting the potential for development or use of groundwater in this area, the risk of exposure due to ingestion of groundwater would be minimized. Continued enforcement of these controls would effectively address the health and environmental risk concerns by preventing ingestion of groundwater containing constituents above remediation goals. In addition, the long-term groundwater monitoring program would track the extent of downgradient contaminants.

The construction of caps on the SWDA and IWS Areas would prevent percolation and resulting contaminant migration from unsaturated zone soils. Since the majority of source materials in the SWDA and IWS Areas are located within the unsaturated zone, the mass-loading of Contaminants of Concern to groundwater from these areas would be significantly reduced. This, along with groundwater flushing, dispersion and natural degradation processes, would result in some improvement in groundwater quality. Additionally, the effects of erosion or leaching of contaminated soils would be minimized by cap construction.

The source control groundwater extraction system would prevent the migration of Contaminants of Concern in groundwater from the area encompassing the SWDA and IWS Areas 1, 2, and 3. However, under this or any other alternative, levels in groundwater within the SWDA and IWS Areas (the area contained by the Alternative 3 extraction system), may remain above remediation goals, although they would be reduced due to the effects of the caps and groundwater flushing, dispersion, and natural degradation processes. The degree of improvement would be dependent on the extent to which source material (DNAPL) that may be within the saturated zone in the area encompassing the SWDA and IWS Areas may continue to impact groundwater. Therefore, timeframe for reduction of levels to remediation goals within the contained area is not predictable within the foreseeable future. Constituent levels downgradient of the extraction system would not reduce to remediation goals for approximately 60 years.

Extracted groundwater would be treated prior to discharge.

The expected cone of influence (Figure 4-8) developed due to groundwater extraction would have a radius of approximately 1,000 feet (the cone of influence is the area within which water table lowering would occur; this is not the same as the capture zone (Figure 4-9), which is the area of the aquifer where all water enters the well). As shown in Figure 4-8, the predicted lowering of the water table within the wetlands areas caused by groundwater extraction would be small (1.5 to 2 feet). Due to the presence of low-permeability soils separating the wetlands associated with the upper portions of the Unnamed Stream and the water table, as well as the limited drawdown from pumping, impacts to the wetlands due to groundwater extraction would be minimal. Because of the large separation between the lower reaches of the Unnamed Stream and the water table, the 1.5 to 2 feet of drawdown resulting from groundwater pumping is expected to have no impact upon those reaches of the stream. The portion of the Unnamed Stream between IWS 2 and the Passumpsic River is a losing stream, separated from the water table by a distance of 11 to 15 feet. The groundwater elevation in the Lower Proximal in the vicinity of IWS 2 is approximately 15 feet below the Unnamed Stream. The groundwater elevation in the Lower Proximal in the vicinity of Riverside School is approximately 11 feet below the elevation of the Unnamed Stream. Piezometer data presented in the RI report confirm that this portion of the Unnamed Stream is a losing stream. Given the large separation from the water table, the stream is likely under gravity drainage, especially under low flow conditions. Therefore, a 1.5 to 2 foot change in the water table would not affect the stream loss rate. As described under Alternative 2, construction of the SWDA cap would impact the Unnamed Stream along the northeastern SWDA border, where it may be routed through a culvert beneath the cap or be relocated adjacent to the cap. The design of the caps for the SWDA and IWS Areas will include a storm water system complete with a detention pond which could incorporate wetlands mitigation through development into an engineered wetlands after establishment of vegetation on the landfill cap. Alternative wetlands mitigation methods will be reviewed and incorporated into the design phase of the project, once the amount of wetlands impact and mitigation action required is determined.

Compliance with ARARs - Alternative 3

Table 4-3 summarizes the ARARs for Alternative 3. The ARARs compliance scenario for Alternative 3 would be similar to that for Alternative 2 with the following significant differences and additions.

- Alternative 3 will achieve state and federal ARARs for groundwater protection standards (or be waived on the grounds of technical impracticability).

- This alternative will comply with the substantive portions of applicable RCRA air emissions standards and consider proposed RCRA air emissions standards and guidance for air strippers.

- Discharge of treated groundwater to the Passumpsic River would require compliance with the substantive requirements of the NPDES discharge program. The NPDES program would contain limitations on effluent quality.

- Alternative 3 would comply with the substantive requirements of the Vermont Water Quality Standards and federal ambient water quality criteria for treated groundwater discharge to the Passumpsic River.

- Alternative 3 would comply with the requirements of the Vermont Hazardous Waste Regulations for the management of hazardous waste generated and shipped off-site as a result of a remedial measure.

Alternative 3 also promotes compliance with drinking water standards and groundwater protection standards for organic contaminants downgradient of the SWDA and IWS Areas by removing them from groundwater, although constituent levels may not reach drinking water standards for some period of time.

Long-Term Effectiveness and Permanence - Alternative 3

The evaluation of Long-term Effectiveness and Permanence presented below considers, as appropriate, the magnitude of residual risk, and adequacy and reliability of controls. An assessment of the long-term impacts on groundwater of this alternative is also included.

As with Alternative 2, the risk of direct exposure to soil and debris containing Contaminants of Concern would be eliminated by construction of the caps and the enforcement of land use restrictions. Implementation of institutional controls to prevent the use of impacted groundwater as a drinking water supply would address the risk associated with groundwater ingestion. Residences downgradient of the SWDA and IWS Areas where Contaminants of Concern have been detected are currently or have the option of being connected to the Village of Lyndonville municipal water supply system.

Under Alternative 3, groundwater quality would improve due to: 1) the effect of the caps, which would isolate the majority of potential source materials in the SWDA and IWS Areas; and 2) the effect of the source control extraction system, which would prevent the migration of groundwater containing Contaminants of Concern above remediation goals beyond the SWDA and IWS Areas. The degree and timeframe for improvement within the area contained by the caps and groundwater extraction system is unpredictable within the foreseeable future, because the mass of Contaminants of Concern that may be present in the saturated zone as DNAPL and represent a continuing source of constituents to groundwater cannot be accurately determined. Therefore, the risk of exposure to impacted groundwater would be addressed in the long-term by institutional controls. However, a remediation timeframe can be estimated for groundwater downgradient of the extraction system.

A calculation of time to achieve concentration reductions downgradient of the source control extraction system was performed using an adaptation of the mixed linear reservoir or "batch flush" model (EPA, 1988b; 1988c) (Appendix D). As noted in the model documentation, the methodology results in log/linear function of concentration and time. The function is dependent upon the starting concentrations and the soil-water partitioning coefficients (K_d) of the organic compounds. The starting concentrations were estimated by using the highest concentration of the compounds detected in any monitoring well located downgradient of the source control wells. The K_d values were calculated from published K_{ow} or K_{oc} values for each compound detected.

Based on these calculations, constituent levels would not reduce to remediation goals downgradient of the extraction system for approximately 60 years following installation and start-up of the extraction system. Therefore, the long-term effectiveness of this alternative, with respect to potential exposure to groundwater, downgradient of the source control system, would also result primarily from the implementation of institutional controls.

The reliability of the controls implemented under Alternative 3 to prevent direct exposure to soil and debris would be the same as that discussed under Alternative 2.

Extraction well systems have been proven reliable as containment systems. Periodic repair/replacement of the extraction well pumps would be required. In addition, redevelopment of selected extraction wells may be necessary if siltation of the sand pack significantly decreases the well yield. However, the short-term nature of these routine maintenance items would not impair the effectiveness of the recovery system. Fouling of groundwater extraction wells sometimes occurs from either of two causes; either bacteriological or incrustation. Incrustation resulting from sedimentation plugging pores of the sand and the well screen openings can be minimized by proper well development and screen opening sizing. In some areas with appreciable iron levels in groundwater, iron bacteria are known to live. They are non-injurious to human health, but can cause plugging of pores and well screens. The bacteria produce accumulations of slimy material, a result of the life cycle of the organisms, which can result in a plugging effect. In areas where incrustation is commonly seen, routine maintenance procedures to address these problems are undertaken. These can include both chemical and physical treatment. Chemical treatment commonly takes the form of acid or oxidizer addition into the well, in a backflushing operation. Physical treatment includes backflushing with water or air. Monitoring of the pump performance can provide indication of well system fouling. Well construction incorporating removable "strips" dedicated to indicating bacterial growth formation can allow actions to be taken prior to gross system fouling. At this site, introduction of chemical treatment into the groundwater would be a last recourse, due to the stringent groundwater treatment effluent quality criteria anticipated under the NPDES program.

The groundwater treatment system would reliably reduce the levels of Contaminants of Concern to discharge limits. Treatment equipment such as pumps, mixers, and blowers would need periodic maintenance and replacement. Additionally, the piping system to the Passumpsic River would need to be periodically inspected and repaired, if necessary.

Reduction of Toxicity, Mobility, or Volume - Alternative 3

The evaluation of Reduction of Toxicity, Mobility, or Volume Through Treatment presented below considers, as appropriate, the treatment processes and materials treated, the amount of hazardous materials destroyed or treated, the degree of expected reduction in TMV, the degree to which treatment reduces the inherent hazards posed by principal threats at the site, the degree to which treatment is irreversible, and the type and quantity of residuals remaining after treatment.

Air Stripping/GAC would permanently remove organic Contaminants of Concern from extracted groundwater. Under Alternative 3, assuming an average groundwater extraction rate of 100 gpm, and an average groundwater concentration of 1.4 mg/l (VOC and SVOC), it is estimated that an average of 670 g/day (1.5 lbs/day) total VOC/SVOC would be removed by the treatment system. Although the toxicity of Contaminants of Concern in extracted groundwater would be permanently reduced through treatment, the overall toxicity would not be reduced, since the constituents would simply be transferred to another medium. Spent carbon would contain concentrated levels of Contaminants of Concern, and would require appropriate treatment/recycling or disposal. Dewatered sludge from the inorganics pretreatment system would also require testing and proper disposal.

The degree to which treatment would reduce the inherent hazards posed by contaminants in groundwater within the SWDA and IWS Areas cannot be calculated, because the total mass of contaminants that may leach to groundwater cannot be reliably estimated. However, this reduction would be minimal, since the human health and environmental risk associated with Contaminants of Concern would be primarily controlled through institutional controls. The timeframe for reduction of levels to remediation goals within these areas is not predictable within the foreseeable future. Levels in groundwater downgradient of the extraction system would not reduce to remediation goals for approximately 60 years. The presumptive remedy (capping) and institutional controls would minimize the inherent hazards posed by principal threat wastes by preventing direct contact with Contaminants of Concern and preventing the ingestion of groundwater impacted by the site. Residences downgradient of the SWDA and IWS Areas where Contaminants of Concern have been detected are currently or have the option of being connected to the Village of Lyndonville municipal water supply system.

As with all of the alternatives involving groundwater treatment, the toxicity of Contaminants of Concern in extracted groundwater would be permanently reduced through treatment; however, the overall toxicity would not be reduced, since the constituents would simply be transferred to another medium, which would require treatment or disposal.

Residuals remaining after treatment under Alternative 3 would include organic constituents concentrated in spent carbon from the GAC systems and waste sludge from the inorganics pretreatment system. Using the Calgon model, the theoretical constituent liquid carbon usage was determined to be approximately 0.1 lbs C/1,000 gallons water treated or 14.4 lbs per day.[2] By using the same model, the theoretical vapor-phase carbon usage was determined to be approximately 0.08 lbs C/1,000 gallons water treated or 11 lbs/day. Based on an average inorganic concentration of 682 mg/l and an average groundwater extraction rate of 100 gpm, a preliminary estimate of the sludge generated is as follows:

- raw sludge solids (dry weight): 819 lbs/day;
- raw sludge volume: 4,910 gallons/day; and
- dewatered sludge at 35% solids: 2,340 lbs/day.

Backup calculations for carbon usage and sludge generation are summarized in Appendix C. As shown above, the amount of sludge generated from inorganics pretreatment would be significant and the sludge may be classified as a hazardous waste based on Toxicity Characteristic Leaching Procedure (TCLP) metals concentrations.

<u>Short-Term Effectiveness - Alternative 3</u>

The evaluation of Short-Term Effectiveness presented below considers, as appropriate, protection of the community and workers during the remedial actions, environmental impacts during the remedial actions, and time until protection is achieved.

The impacts on the community and workers during implementation of Alternative 3 would be similar to those associated with Alternative 2, since they would primarily be associated with cap construction. The groundwater extraction, treatment, and discharge activities associated with this alternative should result in minimal additional risk. Some risk to workers and the community would occur during construction of the outfall pipeline to the Passumpsic River. Typical risks associated with pipeline trench excavation could be minimized by following OSHA construction and confined space entry regulations under 29 CFR Parts 1910 and 1926. Some

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[2] Carbon usage rate modeling was based on a preliminary VOC/SVOC concentration of 1.23 mg/l. Final concentration determination yielded 1.44 mg/l VOC/SVOC. This resultant variation of carbon use falls well within the degree of acceptable costing accuracy of this report.

disruption of vehicular or train traffic could occur if the pipeline was constructed along roads or across the railroad tracks. Construction of an outfall diffuser in the river would pose some level of temporary controllable risk to workers. Compliance with a health and safety plan and erosion and sedimentation control plan would be required during cap construction, well installations, and construction and operation of the treatment system.

The environmental impacts associated with cap construction discussed under Alternative 2 would apply to Alternative 3 as well. As discussed under Overall Protection of Human Health and the Environment, wetlands impacts associated with groundwater extraction under this alternative should be minimal. The extraction system would need to be designed and installed in a manner that would avoid disturbance of potentially remobilizable contaminants.

The beneficial results of the cap and source control groundwater extraction system would occur almost immediately upon their implementation. Direct contact with soil and debris would be prevented by the cap. Although there would be some short-term reduction of contaminant levels as compared to alternatives that do not include groundwater extraction, there would be no short-term attainment of groundwater remediation goals under this or any other alternative. Short-term protectiveness would be achieved, however, through the implementation of institutional controls. The time required to implement Alternative 3 is estimated in the following table:

TASK	MONTHS
Predesign Activities	7
Design (Preliminary through Final)	9
Equipment/Material/Contractor Procurement	2
Site Preparation	2
Construction of Cap/Groundwater Extraction/Treatment System	16
Vegetation of Cap	3
Total Estimated Implementation Time (Calendar)	30

Schedule development at this phase of the project must be performed conservatively, and is subject to change based on design parameters and site conditions encountered including climate impacts on field/construction activities. It is possible that this schedule will expand or shrink as more detailed design activities are undertaken.

Implementability - Alternative 3

The implementability evaluation presented below considers the ability to construct and operate technologies, the reliability of technologies, the ability to monitor the effectiveness of the remedy, the availability of services and materials, the administrative feasibility, and the availability and capacity of off-site treatment, storage, and disposal facilities (TSDFs).

Implementability issues associated with the cap discussed under Alternative 2 would also apply to Alternative 3. Construction of the cap would utilize standard construction techniques and equipment. The materials that comprise each of the evaluated cap designs are available in the vicinity of the SWDA and IWS Areas, or could be delivered within a reasonable time frame. As with Alternative 2, periodic monitoring of cap integrity would be easily implemented.

Extraction wells can be installed using known techniques. Services and materials would be available. The drilling, installation and operation of extraction wells would be implemented taking into consideration the potential presence of DNAPL within the subsurface. Chlorinated solvent DNAPL, when released to the subsurface, generally reaches a stable configuration relatively quickly, and does not migrate further unless disturbed. Therefore, remedial measure would be designed to avoid disturbance of these materials. This would be accomplished by placing pumping wells outside of potential DNAPL zones and by minimizing pumping rates and resulting changes in pore pressure.

There are no major impediments to implementing a groundwater treatment system due to site and climatic conditions. However, the very high concentrations of inorganics which are not toxic materials would negatively impact the operation of organic removal systems, and would require costly pretreatment. Precipitation of inorganic materials via hydroxide/carbonate formation is adequate for most pretreatment requirements, but in this case it would result in significant amounts of sludge which may be a TCLP metals hazardous waste. Air stripping followed by GAC is a reliable treatment technology even with variations in groundwater flow and concentrations. The entire treatment system, because of local climate, would be protected in a heated building. Carbon columns, replacement GAC, and equipment and materials required for hydroxide/carbonate precipitation are available. Effluent quality criteria developed under the Vermont NPDES program will impact the treatment system design in terms of technical ease or feasibility of attaining discharge limits. Removal and treatment of residual from the groundwater treatment system would require properly trained personnel.

Construction of the discharge pipeline to the Passumpsic River would utilize standard construction techniques and materials, which would be readily available. Easements would be required. Actions to procure those easements, particularly for all railroad crossings, should be initiated at least 12 months prior to construction. A NPDES permit would not be required for discharge of the treated groundwater to the Passumpsic River; however, the substantive requirements of the NPDES program would have to be met.

Groundwater monitoring to assess the effectiveness of the cap and source control groundwater extraction system would not be difficult to implement since monitoring is ongoing and could be continued. Institutional controls preventing groundwater use would be implementable, since a public water supply is available to the impacted area, but the cooperation of landowners, the Town, and the State of Vermont would be required.

As mentioned previously, organic constituents would be concentrated in spent carbon. There are several liquid and vapor GAC vendors who regenerate carbon as part of their services. These companies would retrieve spent carbon, replace it with regenerated carbon, and haul the spent carbon to their recycling facility. Although carbon disposal may be possible at local municipal landfills, all materials disposed of in that manner would need state approval, and no hazardous waste would be accepted. In addition, it is unlikely that local municipal landfills would accept delisted hazardous waste. Dewatered sludge from the inorganics pretreatment system would require sampling and analysis to determine its status as a TCLP metals hazardous waste and the proper method for disposal.

Currently, approved hazardous waste disposal facilities are located in New York, Ohio, Indiana, and Maine. Waste transportation to these facilities would be expensive and some of these landfills also have restrictions in accepting hazardous waste. Long-term disposal of hazardous waste is uncertain because of difficulties in siting new hazardous waste disposal facilities. In the case of sludge from the pretreatment step, this problem could be critical because of the volume of sludge. The volume is due not to levels of heavy metals, but to nontoxic inorganics. However, the volume of sludge which may be TCLP hazardous waste exceeds by several orders of magnitude the volume of organics removed in treatment. Removal and treatment of residual materials from operation of the groundwater treatment system would require properly trained personnel.

Cost Analysis - Alternative 3

The cost sensitivity analysis resulted in the preparation of low-, medium- and high-case cost scenarios for both the capital and operation and maintenance costs of Alternative 3.

Primary capital, operation, and maintenance cost assumptions that were varied specifically pertaining to Alternative 3 include (these assumptions were also varied for other alternatives involving source control groundwater extraction - Alternatives 5 and 8B):

- the total groundwater extraction rate, which influences the mass loading rate and treatment system operation requirements and materials generation;

- the extraction and treatment system(s) sizing;

- the frequency of treated groundwater discharge and treatment system sampling and analysis;

- the frequency of monitoring and sampling and the number of wells included in the monitoring/sampling program;

- the extent of the wetlands mitigation programs, if required; and

- the amount and cost of equipment requiring replacement in 15 years.

Additional factors varied and specific numbers utilized in the cost assumptions and factors in the cost sensitivity analysis of Alternative 3 are presented on the detailed cost assumptions lists in Appendix C. Estimated costs for the Alternative 3 cost scenarios (medium, high and low) are significantly higher (100%) than those associated with Alternative 2. The cost estimates for Alternative 3 are presented in the following table (total present worth costs are rounded to the nearest $100,000).

Cost Case Scenario	Capital Cost	Annual O&M Cost	Present Worth Annual O&M Cost	Present Worth Non-annual O&M Cost	Total Present Worth
3 - Medium	$15,450,000	$1,000,000	$12,410,000	$300,000	$28,200,000
3 - High	$20,230,000	$1,400,000	$17,370,000	$400,000	$38,000,000
3 - Low	$11,890,000	$550,000	$6,820,000	$300,000	$19,000,000

4.3.4 Alternative 4: Containment (SWDA, IWS 1, 2, and 3)/In-situ Soil Vapor Extraction of IWS 2 Materials/No Source Control Groundwater Extraction

4.3.4.1 Description

Alternative 4 would include the capping measures outlined under Alternative 2, and installation and operation of an SVE system at IWS 2 to remove VOC from the unsaturated zone soil.

Specifically, Alternative 4 includes implementation of the following measures:

- possible temporary relocation of seven mobile homes on the northern side of the SWDA during cap construction activities;

- regrading of the SWDA to achieve appropriate slopes and drainage for cap;

- possible re-routing of a limited portion of the Unnamed Stream beneath or adjacent to the SWDA cap;
- construction of a composite-barrier (RCRA) cap on the SWDA and IWS 1 Area and separate RCRA caps on the IWS 2 and 3 Areas;
- potential waste reconfiguration to minimize wetland impacts;
- installation and operation of an active gas collection system and central gas treatment (flaring) system in SWDA and IWS Areas;
- installation of perimeter storm water ditches and a storm water retention pond to manage the surface runoff from the caps;
- revegetation of the capped areas to control erosion;
- construction of a fence around the capped areas to deter unauthorized access;
- possible wetlands mitigation, if adversely impacted;
- **design and installation of a SVE system within IWS 2;**
- **long-term (15 years) monitoring and maintenance of the soil vapor extraction system;**
- **air treatment by GAC polishing (an alternative technology may be selected during design phase);**
- **off-site disposal and/or further treatment or destruction of SVE treatment system residuals;**

- institutional controls/deed restrictions to limit intrusive activities in the capped area and prevent use of impacted groundwater containing constituents above remediation goals;

- long-term groundwater, surface water, and sediment monitoring; and

- a five-year site review to evaluate the effectiveness and adequacy of remedial measures including engineering review of geosynthetic performance under field conditions.

Soil vapor extraction involves the installation of surface-mounted air vacuum pumping equipment and a network of buried vacuum lines or wells located in target areas of known volatile constituents present in the unsaturated zone. As the lines are evacuated, volatile compounds in the vadose zone partition to the air phase and are collected by the vacuum collection system. The following discussion provides additional detail regarding the measures that would be implemented under Alternative 4.

<u>Soil Vapor Extraction</u>

Alternative 4 would be similar to Alternative 2, except that a SVE system would be installed at IWS 2 to remove VOC from the unsaturated soil in this area. By extracting VOC from the soil, the mass of Contaminants of Concern would be reduced in the IWS 2 Area.

The soil vapor extraction area would encompass the concentrated contamination of the IWS 2 Area. See Figure 4-10 for SVE extraction point locations. Soil vapor extraction is accomplished by drawing air through contaminated soil and volatilizing trapped volatile and semivolatile compounds from the pore spaces of subsurface soils. Dissolved and adsorbed compounds would continue to volatilize and evaporate into inter-granular pore spaces until equilibrium of the liquid and vapor phases is achieved in the pore spaces. Soil vapor containing VOC would be removed via extraction wells.

A vacuum is created in the subsurface using a high vacuum regenerative blower manifolded to a series of vertical or horizontal screened well points. The vacuum causes air to be pulled from surrounding subsurface soils into the well points and thus to the regenerative blower. For the preliminary planning purpose of the FS, it is assumed that extracted soil vapor would be treated with vapor-phase GAC and discharged to the atmosphere. During the design phase, alternative methods would be evaluated. Evaluation and selection of potential extraction and injection configurations would be conducted during pre-design activities. Soil vapor probes would be installed to monitor the effectiveness of the remediation.

Average total air flow rates were calculated based on the hydraulic conductivity of subsurface soils at IWS 2. The radius of influence for each well is anticipated to be 75 feet. For the preliminary planning purpose of the FS, it is estimated that two wells with 2-inch diameter well screens would be installed to a depth of 10 feet. Based on the assumed air flow rate of 90 CFM, the SVE system would consist of four 1,800 lb vapor-phase carbon units. Soil vapor extraction system sizing was based on concentrations of contaminants found in soil borings (See Figure 4-10 and Table C4-51). Calculations were performed to develop anticipated concentrations over time. Costs incorporate usage rates from year 5 concentrations for 15 years. However, during year 1, concentrations are anticipated to be much higher. The design of four vessels allows flexibility of system operation to compensate for wide variations in contaminant concentrations over the life of the operation. It is anticipated that the soil vent system would operate periodically, running until the analytical data indicate SVE system discharge contains only low levels of volatiles. Volatile contaminants in the saturated layers below the soil vent system will continue to transport to the unsaturated soils and "re-contaminate" the area. The vent system would then be re-activated. A total of 15 years of SVE system operation takes into account this variable usage and the unknown mass of contaminants in the soil and the groundwater, and unknown flow and mass loading rates. Subsequent to conducting a SVE pilot test, more refined data will be available for detailed system design.

The units would be approximately seven feet tall and five feet in diameter. However, as there are many standard units on the market and there is significant flexibility in design the parameters discussed previously, ready-made carbon units which would meet the system requirements would be used.

Predesign Studies

The predesign studies that would be performed to support design of Alternative 4 would include the predesign studies associated with cap design and construction (see Alternative 2). Additional predesign investigations would also potentially include:

- A soil and air sampling program to support SVE treatability testing and air discharge requirements; and

- A SVE pilot test to refine air flow/radius of influence and mass loading characteristics and support the design of the SVE system.

4.3.4.2 Alternative 4 - Detailed Evaluation

The following discussion presents the detailed evaluation for Alternative 4.

Overall Protection of Human Health and the Environment - Alternative 4

The evaluation of the Overall Protection of Human Health and the Environment presented below includes consideration of human health protection (with respect to the potential for direct contact with soil and debris and groundwater ingestion), and environmental protection (wetlands effects and groundwater effects).

The Protection of Human Health and the Environment under Alternative 4 would be similar to Alternative 2. The caps, deed restrictions, and fencing would prevent direct contact with soil and debris. The caps would minimize impacts to sediment in the adjacent wetlands. No additional protection of human health would result from removal of VOC from the IWS 2 Area as a result of operating the SVE system. However, some additional exposure may result during installation of the system to personnel installing SVE wells and assembling equipment prior to system startup and operation. In addition, transport and disposal or destruction of residual materials that would be generated during the SVE system operation (i.e., spent carbon) would result in additional potential exposure to human health and the environment.

The risk of exposure due to ingestion of groundwater would be minimized through implementation of institutional controls limiting the development or use of groundwater in the impacted area. The residences downgradient of the SWDA and IWS Areas where Contaminants of Concern have been detected are currently, or have the option of being connected to the Town of Lyndonville's municipal water supply system.

The installation of the impermeable caps over the SWDA and IWS Areas would significantly reduce the mass-loading of Contaminants of Concern to the groundwater from these areas and result in an improvement in downgradient groundwater quality. Concentrations could remain greater than the remediation goals, but would be reduced due to the effects of the caps and by groundwater flushing, dispersion and natural degradation. The degree of groundwater quality improvement and the timeframe for reduction of levels to remediation goals is not predictable within the foreseeable future.

Wetland impacts would be associated with cap construction as described under Alternative 2. The physical impacts to wetlands would be primarily associated with filling and excavation activities as a result of cap construction. The design of the caps for the SWDA and IWS Areas will include a storm water system including a detention pond. Engineered wetlands could be constructed in the detention pond subsequent to cap construction. The presence of caps over the SWDA and IWS Areas would effectively eliminate the infiltration of rain water and, in turn, the development and migration of leachate into adjacent wetlands. Surface runoff of rain or snowmelt would also remain uncontaminated as it would migrate through or over clean, vegetated fill, also minimizing impacts of wetlands. Wetlands mitigation methods will be determined during detailed design, based on the actual wetlands impact of the cap design and construction.

No additional protection of the environment at IWS 2 would result from installation and operation of the SVE system, as the RCRA cap to be installed at this location would isolate Contaminants of Concern present in the unsaturated zone, prevent contact with soil, and eliminate migration of constituents from the unsaturated zone into groundwater via rainfall infiltration. There may be some increased environmental risk associated with installation and operation of the SVE system in the IWS 2 Area.

Compliance with ARARs - Alternative 4

Table 4-4 summarizes ARARs for Alternative 4. The ARARs compliance scenario for Alternative 4 is essentially the same as that for Alternative 3.

Long-Term Effectiveness and Permanence - Alternative 4

The evaluation of Long-term Effectiveness and Permanence presented below considers, as appropriate, the magnitude of residual risk, and adequacy and reliability of controls. An assessment of the long-term impact of this alternative on groundwater is also included.

The potential residual risk associated with Alternative 4 would be similar to that associated with Alternatives 2 or 3, since the cap would prevent direct contact with soil and debris, and institutional controls would address the potential for groundwater ingestion. Some VOC would be permanently removed from soil at IWS 2 through operation of the SVE system. However, residual material from the operation of the SVE system would require off-site treatment or disposal. Furthermore, the long-term effectiveness of the SVE System may be limited due to the presence of low permeability soils and the presence of debris which would cause VOC removal along preferential pathways, while high concentration areas would remain. Additionally, volatilization of contaminants from impacted groundwater will continue to provide a source of VOC in the soils.

The SVE system that would operate at IWS 2 would have minimal impact on groundwater quality, as the SVE system would only remove VOC from the unsaturated zone. The RCRA cap alone would prevent potential groundwater impacts associated with the unsaturated zone. Furthermore, groundwater data indicate that the IWS 2 Area is not significantly impacting downgradient groundwater even under current conditions (without a cap). The concentrations of Contaminants of Concern in IWS 2 groundwater are 1.5 to 2 orders of magnitude lower than observed in the groundwater in other IWS Areas.

Under Alternative 4, groundwater containing Contaminants of Concern would continue to migrate beyond the SWDA and IWS Areas, although groundwater quality would be improved due to the effect of the caps. Because there may continue to be source areas within the saturated zone in the area encompassed by the SWDA and IWS Areas, concentrations of Contaminants of Concern in downgradient groundwater could remain greater than the remediation goals, although they would be reduced due to the effect of the caps and groundwater flushing, dispersion and natural degradation processes. The degree of groundwater quality improvement and the timeframe for reduction of levels in groundwater to remediation goals is not predictable within the foreseeable future. Therefore, the risk of exposure to impacted groundwater would be addressed in the long-term through institutional controls.

Reduction of Toxicity, Mobility or Volume - Alternative 4

The evaluation of Reduction of Toxicity, Mobility, or Volume Through Treatment presented below considers the treatment processes and materials treated, the amount of hazardous materials destroyed or treated, the degree of expected reduction in TMV, the degree to which treatment reduces the inherent hazards posed by principal threats at the site, the degree to which treatment is irreversible, and the type and quantity of residuals remaining after treatment.

The operation of a soil vapor extraction system within the IWS 2 Area would effectively reduce the TMV through treatment; however, the overall toxicity would not be reduced, since the constituents would simply be transferred to another medium. Assuming an air flow rate of 90 cubic feet per minute (CFM), and an average air-phase VOC concentration (calculated from soil concentrations) of 1.6×10^{-6} lb/ft^3, it is estimated that an average of 0.2 lbs/day VOC would be removed by the SVE treatment system. The treatment residuals generated would include approximately 18 lbs per day spent carbon from the GAC system. Based on Calgon modeling and assuming an air flow rate of 90 CFM, the theoretical carbon usage was determined to be approximately 0.14 lbs/1,000 CFM. The residual materials would require treatment or disposal. Treatment would effectively destroy constituents, whereas disposal would transfer the liability associated with Contaminants of Concern to another location. Furthermore, not all Contaminants of Concern would be removed from IWS 2. As stated, the SVE system would potentially remove VOC along preferential pathways, and would not address non-volatile organics or metals. Contaminants could continue to migrate from groundwater via vapor diffusion, "re-contaminating" soils.

The degree of expected reduction in TMV cannot be determined, because the total mass of Contaminants of Concern within the SWDA and IWS Areas cannot be accurately calculated. Similarly, the degree to which treatment would reduce the inherent hazard posed by Contaminants of Concern in the SWDA and IWS Areas cannot be reliably estimated; however, this reduction would be minimal, since the human health and environmental risk associated with Contaminants of Concern in the SWDA and IWS Areas would be primarily controlled through capping and institutional controls. For example, removal of VOC via vapor extraction from IWS 2 materials would not significantly reduce the risk posed by these materials, since the cap alone would isolate the unsaturated zone within IWS 2.

Short-Term Effectiveness - Alternative 4

The evaluation of Short-Term Effectiveness presented below considers, as appropriate, protection of the community and workers during the remedial actions, environmental impacts during the remedial actions, and time until protection is achieved.

The impacts to the community, workers, and the environment during implementation of Alternative 4 would be similar to the impacts associated with Alternative 2, since they both involve construction of caps over the SWDA and IWS Areas. However, additional exposure and some increased environmental risk would potentially result during installation and operation of the SVE and treatment system at the IWS 2 Area.

As described under Alternatives 2 and 3, the beneficial results of the caps would occur immediately upon their implementation. Direct contact with soil and debris would be prevented, and infiltration through source material and resulting groundwater impacts would be minimized. There would be no short-term attainment of groundwater remediation goals under this or any other alternative. However, short-term protectiveness would be accomplished through institutional controls preventing groundwater use. The period of time necessary for the SVE system to reduce VOC levels to clean up goals (that would be based on groundwater protection) within IWS 2 cannot be accurately estimated, given difficulties associated with the effective implementation of this measure.

The time to implement Alternative 4 is summarized in the table below.

TASK	MONTHS
Predesign Activities	5
Design (Preliminary through Final)	9
Equipment/Material/Contractor Procurement	2
Site Preparation	2
Construction of Cap/Soil Vapor Extraction System	10
Vegetation of Cap	3
Total Estimated Implementation Time (Calendar)	25

Schedule development at this phase of the project must be performed conservatively, and is subject to change based on design parameters and site conditions encountered including climate impacts on field/construction activities. It is possible that this schedule will expand or shrink as more detailed design activities are undertaken.

Implementability - Alternative 4

The implementability evaluation presented below considers, as appropriate, the ability to construct and operate technologies, the reliability of technologies, the ability to monitor the effectiveness of the remedy, the availability of services and materials, the administrative feasibility, and the availability and capacity of off-site TSDFs.

The implementation of Alternative 4 would utilize standard construction equipment and installation techniques. As with Alternative 2, the capping measures that would be implemented under Alternative 4 have been proven to be reliable at other waste sites, and the services and materials are readily available. Periodic inspections of the caps could be easily implemented to evaluate the effectiveness of the remedy.

Vacuum extraction systems have been installed at other sites, and equipment is available from several vendors. Due to the low permeability of soil and presence of buried debris in IWS 2, it would be difficult to achieve adequate and/or homogeneous air flow. Differences in flow rates across the material can cause VOC constituents to be eliminated sporadically, both spatially and temporarily, leaving VOC in high concentration areas. Differences in flow rates can also cause a pressure differential to form across the blower, resulting in a high operating temperature and associated increased operating costs. Installation of soil probes would allow evaluation of the effectiveness of the SVE removal system. Installation would be performed by available trained personnel. There is a potential for worker exposure during installation of the SVE extraction wells. Also, installation of probes might compromise the integrity of the RCRA type cap over IWS 2.

Removal and treatment of residual materials from operation of the SVE treatment system would require properly trained personnel. As mentioned previously, organic constituents would be concentrated in spent carbon. Treatment residuals from the SVE treatment system would require off-site disposal. For a discussion of the availability of off-site TSDFs, see the evaluation of Alternative 3.

Institutional controls preventing the use of groundwater would be implementable, since the Village of Lyndonville municipal water supply is available to impacted residences. The cooperation of landowners, the Town, and the State of Vermont would be required.

Cost Analysis - Alternative 4

The cost sensitivity analysis resulted in the preparation of low-, medium, and high-case cost scenarios for both the capital and operation and maintenance costs of Alternative 4. Assumptions that were varied when evaluating costs for Alternative 4 include:

- the air flow rates which may impact system sizing and will impact operation and maintenance costs;
- the frequency of treated air discharge and treatment system sampling and analysis;
- mass-loading rates which will impact the amount and cost of carbon; and
- the frequency of monitoring/sampling and the number of monitoring/sampling points in the SVE system monitoring program.

Estimated costs for the Alternative 4 cost scenarios (medium, high and low) are presented in the following table (total present worth costs are rounded to the nearest $100,000). Backup calculations and tables for each alternative are presented in Appendix C.

Cost Case Scenario	Capital Cost	(30 Years) Annual O&M Cost	(30 Years) Present Worth Annual O&M Cost at 7%	(15 Years) Annual O&M Cost	(15 Years) Present Worth Annual O&M Cost at 7%	Present Worth Non-annual O&M Cost	Total Present Worth at 7%
4 - Medium	$12,080,000	$150,000	$1,860,000	$150,000	1,370,000	$150,000	$15,500,000
4 - High	$16,480,000	$250,000	$3,100,000	$250,000	$2,280,000	$200,000	$22,100,000
4 - Low	$8,880,000	$150,000	$1,860,000	$100,000	$910,000	$150,000	$11,800,000

4.3.5 Alternative 5: Containment (SWDA, IWS 1, 2, and 3)/In-Situ Soil Vapor Extraction of IWS 2/Source Control Groundwater

4.3.5.1 Description

Alternative 5 builds upon the components of Alternative 4 (i.e., capping and installation and operation of an SVE system), by including a source control groundwater extraction system (described under Alternative 3). Alternative 5 would involve components similar to those included under Alternative 3, as follows (additional or modified measures are shown in bold type):

- possible temporary relocation of seven mobile homes on the northern side of the SWDA during cap construction activities;
- regrading of the SWDA;
- possible re-routing of a limited portion of the Unnamed Stream beneath or adjacent to the SWDA cap;
- construction of a composite-barrier (RCRA) cap on the SWDA and IWS 1 Area and separate caps on the IWS 2 and 3 Areas;
- potential waste reconfiguration to minimize wetlands impacts;
- installation and operation of active gas collection system and central gas treatment (flaring) systems in SWDA and IWS Areas;
- installation of perimeter storm water ditches and a storm water retention pond to manage the surface runoff from the caps;
- revegetation of the capped areas to control erosion;

- construction of a fence around the capped areas to deter unauthorized access;
- possible wetlands mitigation, if adversely impacted;
- **design and installation of a SVE system within IWS 2;**
- **long-term (15 year) monitoring and maintenance of the SVE system;**
- **air treatment by GAC polishing (an alternative technology may be selected during the design phase);**
- **off-site disposal and/or further treatment or destruction of SVE treatment system residuals;**
- extraction of groundwater to prevent the off-site flow of groundwater that contains concentrations exceeding the remediation goals (see Alternative 3 description);
- groundwater treatment followed by air stripping and GAC polishing; this treatment requires a pretreatment step consisting of inorganics removal using carbonate/hydroxide precipitation;
- discharge of treated groundwater to the Passumpsic River in accordance with NPDES program requirements (alternatives to discharging treated water to the Passumpsic River will be evaluated during pre-design);
- long-term maintenance, monitoring of the groundwater treatment system;
- off-site disposal and/or further treatment or destruction of treatment residuals;
- institutional controls/deed restrictions to limit intrusive activities in the capped area and prevent use of impacted groundwater containing constituents above remediation goals;

- long-term groundwater, surface water, and sediment monitoring; and

- five-year site reviews to evaluate the effectiveness and adequacy of remedial measures, including engineering review of geosynthetic performance under field conditions.

The following discussions provide additional detail regarding Alternative 5.

Groundwater Recovery

Alternative 5 would supplement the remedial measures included under Alternative 4, by providing groundwater source control through operation of a groundwater extraction system. The extraction system would be designed to prevent migration of groundwater containing Contaminants of Concern at concentrations greater than the remediation goals beyond the area encompassed by the SWDA and IWS Areas. The groundwater extraction system for Alternative 5 would be identical to the system outlined under Alterative 3.

As previously discussed under Alternative 3, approximately four wells would be required in the overburden and one well in the fractured bedrock to achieve hydraulic control of the sources. In order to ensure that Contaminants of Concern at any elevation in the Lower Proximal unit would be captured, the overburden wells would be screened through the full saturated thickness of that unit. Based upon the capture-zone analyses presented in Appendix F, the overburden wells would be located on a line downgradient of IWS 1 and IWS 2, at spacings of 250 to 280 feet. These wells would be pumped at between 19 gpm and 25 gpm, or at a combined rate of approximately 85 gpm. The bedrock well would be located in the upper 50 feet of bedrock, just downgradient of IWS 2. Based upon the pump-test conducted in bedrock and the capture-zone analyses presented in Appendix F, a pumping rate of approximately 15 gpm would be necessary for hydraulic control in the fractured bedrock. Therefore, a total source control groundwater extraction rate of approximately 100 gpm is estimated.

Groundwater Treatment

The groundwater treatment system for Alternative 5 would be identical to that described under Alternative 3 and would consist of inorganics pretreatment by hydroxide/carbonate precipitation followed by air stripping and activated carbon polishing.

The sizing of the inorganics pretreatment system was varied in the cost sensitivity analysis. The following values provide an approximate description of the scale of the inorganics pretreatment equipment which would be used to treat extracted groundwater under Alternative 5:

- equalization tank: 12,000 gallons
- flocculation tank: 2,000 gallons
- Clarifier: 18,000 gallons; 16 feet in diameter
- pressure filters (3): 3 feet in diameter
- backwash pump rate: 100 gallons per minute
- chemical storage tanks with metering pumps: (2) 250 gallons
- sludge thickening and dewatering equipment

Following inorganics pretreatment, groundwater would flow through an air stripper three feet in diameter and 17.5 feet tall. Groundwater then would be treated with an activated carbon polish. At an estimated flow rate of 100 gpm, an EBCT of approximately 15 minutes per carbon unit, and a hydraulic loading rate of approximately 4 gpm/ft^2, the GAC system would consist of three canisters (allowing for 20 percent bed expansion during backwash) which are approximately eight feet tall, six feet in diameter, and each containing approximately 5,000 pounds of granular activated carbon each (depending on the specific gravity of the carbon used). Two vessels would be on line in series with one as backup. Air effluent would be treated with an activated carbon polish. Vapor-phase carbon units would consist of one vessel, with two beds, each three feet deep, and each bed containing approximately 6,000 pounds of carbon. However, there are many standard units on the market, and ready-made carbon units which would approximate treatment requirements could be used.

Soil Vapor Extraction

The SVE system installed under Alternative 5 would be identical to that installed for Alternative 4. The soil vapor extraction area would encompass the IWS 2 Area. For the preliminary planning purpose of the FS, it is assumed that extracted soil vapor would be treated with vapor-phase GAC. During the design phase, alternative methods would be evaluated. Evaluation and selection of potential extraction and injection configurations would be conducted during pre-design activities. Soil vapor probes would be installed to monitor the effectiveness of the remediation.

Predesign Studies

The predesign studies that would be performed to support the design of Alternative 5 would be the same as those performed under Alternatives 3 and 4, and would include:

- the studies necessary to support cap construction (see Alternative 2 description);
- the studies necessary to support groundwater treatment design and construction (see Alternative 3 description); and
- the studies necessary to support implementation of a SVE and treatment measure, (see Alternative 4).

4.3.5.2 Alternative 5 - Detailed Evaluation

The following discussion presents the detailed evaluation for Alternative 5. Since Alternative 5 includes many of the components included in Alternatives 3 and 4, the evaluation for many of the criteria will be similar. The following discussions focus in particular on the impacts that the unique components of Alternative 5 would have on the evaluations.

Overall Protection of Human Health and the Environment - Alternative 5

The evaluation of the Overall Protection of Human Health and the Environment presented below includes consideration of human health protection (with respect to the potential for direct contact with soil and debris and groundwater ingestion), and environmental protection (wetlands effects and groundwater effects).

The Protection of Human Health and the Environment under Alternative 5 would be similar to Alternatives 3 and 4. The cap, deed restrictions, and fence would prevent direct contact with soil and debris and minimize impacts of sediment in the adjacent wetlands by controlling surface runoff and erosion in the SWDA and IWS Areas. Implementation and enforcement of institutional controls would effectively address health risk concerns with respect to groundwater, even without implementation of a groundwater extraction system, by preventing the ingestion of groundwater containing constituents above remediation goals.

Installation and operation of the source control groundwater extraction system would prevent the migration of groundwater impacted by sources within the area encompassing the SWDA and IWS Areas. Figures 4-8 and 4-9 show the predicted horizontal cone of influence and approximate extent of the groundwater capture zone for this alternative, which would be the same as Alternative 3. Groundwater concentration reductions within the boundary of the SWDA and IWS Areas cannot be predicted because this area is within the source area capture zone and the rate at which potential saturated zone sources would deplete cannot be reliably estimated. Therefore, the timeframe for reduction of levels to remediation goals within the contained area is not predictable within the foreseeable future. Using TCE as an indicator compound, calculations indicate that groundwater concentrations downgradient of the SWDA and IWS Areas would not reduce to below drinking water standards for approximately 60 years.

Wetlands impacts would be associated with cap construction and excavation activities as described under Alternative 2. The physical impacts to wetlands would be primarily associated with filling and excavation activities as a result of cap construction. The design of the caps for the SWDA and IWS Areas will include a storm water system including a detention pond. The presence of caps over the SWDA and IWS Areas would effectively eliminate the infiltration of rainwater and, in turn, the development and migration of leachate into adjacent wetlands. Surface runoff of rain or snowmelt would also remain uncontaminated as it would migrate through or over clean, vegetated fill, also minimizing impacts to wetlands. Wetlands mitigation methods will be determined during detailed design, based on the actual wetlands impact of the cap design and construction.

Soil vapor extraction at IWS 2 would not increase the overall protection of human health and the environment, as the constituents removed by the SVE system would already be isolated by the RCRA cap constructed at this location. As discussed under Alternative 4, operation of the SVE system would not impact the groundwater quality downgradient of the extraction system. Some exposure may occur due to the SVE system construction and maintenance and the necessity of handling and treating residuals from the SVE treatment system.

Compliance with ARARs - Alternative 5

Table 4-3 summarizes ARARs for Alternative 5. The ARARs compliance scenario for Alternative 5 is the same as that for Alternative 3 and Alternative 4 with respect to the operation of the SVE System.

Long-Term Effectiveness and Permanence - Alternative 5

The evaluation of Long-Term Effectiveness and Permanence presented below considers, as appropriate, the magnitude of residual risk and adequacy and reliability of controls. An assessment of the long-term impact of this alternative on groundwater is also included.

The magnitude of residual risk, and adequacy and reliability of controls under Alternative 5 would be similar to that discussed under Alternative 3. Some additional risk may result from potential exposure to treatment residuals from the SVE treatment system.

Implementation of SVE in IWS 2 would have minimal impact on groundwater quality, since source materials in the unsaturated zone within IWS 2 would be isolated by the cap alone. Furthermore, RI data indicate that sources in the IWS 2 Area are not significantly impacting groundwater. Under Alternative 5, as with all of the other alternatives, there may continue to be source areas within the saturated zone within the area encompassed by the SWDA and IWS Areas. Therefore, the concentrations of Contaminants of Concern within the area contained by the extraction system could remain greater than the remediation goals, although they would be reduced due to the effect of the caps and groundwater flushing, dispersion, and natural degradation processes. The degree of groundwater quality improvement and the timeframe for reduction of levels to remediation goals within the contained areas is not predictable within the foreseeable future. Therefore, the potential for ingestion of groundwater within this area will be addressed in the long-term through institutional controls.

Under Alternative 5, as with Alternative 3, the downgradient groundwater concentrations would not achieve remediation goals for approximately 60 years following installation and start-up of the extraction system. Therefore, the long-term effectiveness of this alternative, with respect to potential exposure to groundwater downgradient of the source control extraction system, would also result from the implementation of institutional controls. The calculation of time to achieve concentration reductions used an adaptation of the mixed linear reservoir or "batch flush" model (EPA, 1988b; 1988c). As noted in the model documentation, the methodology results in log/linear function of concentration and time. The function is dependent upon the starting concentrations and the soil-water partitioning coefficients (K_d) of the organic compounds. The starting concentrations were estimated by using the highest concentration of the compound detected in any monitoring well located downgradient of the source control wells. The K_d values were calculated from published K_{ow} or K_{oc} values for each compound detected.

As discussed in the evaluations of Alternatives 3 and 4, the controls implemented under Alternative 5 would be reliable, requiring routine maintenance activities.

Reduction of Toxicity, Mobility, or Volume - Alternative 5

The evaluation of Reduction of Toxicity, Mobility, or Volume Through Treatment presented below considers, as appropriate, the treatment processes and materials treated, the amount of hazardous materials destroyed or treated, the degree of expected reduction in TMV, the degree to which treatment reduces the inherent hazards posed by principal threats at the site, the degree to which treatment is irreversible, and the type and quantity of residuals remaining after treatment.

As with all of the alternatives involving groundwater treatment, the toxicity of Contaminants of Concern in extracted groundwater would be reduced through treatment; however, the overall toxicity would not be reduced, since the constituents would simply be transferred to another medium. The residual material would require treatment or disposal at another location.

The degree of expected reduction in TMV cannot be determined, because the total mass of Contaminants of Concern within the area encompassing the SWDA and IWS Areas cannot be accurately calculated. Similarly, the degree to which treatment would reduce the inherent hazard posed by Contaminants of Concern in the SWDA and IWS Areas cannot be reliably estimated; however, this reduction would be minimal, since the human health and environmental risk associated with Contaminants of Concern in the SWDA and IWS Areas would be primarily controlled through capping and institutional controls. For example, removal of VOC via vapor extraction from IWS 2 materials would not significantly reduce the risk posed by these materials, since the cap alone would isolate the unsaturated zone within IWS 2. Although groundwater extraction and treatment would remove toxicity from the groundwater, the timeframe for reduction of levels in groundwater within the SWDA and IWS Areas is unpredictable within the foreseeable future. Downgradient of the extraction system, groundwater standards would not be reached for approximately 60 years. Therefore, the risk of exposure to groundwater will be primarily controlled through implementation of institutional restrictions on groundwater use.

As with all of the alternatives involving groundwater treatment, the toxicity of Contaminants of Concern in extracted groundwater would be permanently reduced through treatment; however, the overall toxicity would not be reduced, since the constituents would simply be transferred to another medium, which would require treatment or disposal.

Under Alternative 5, assuming an average groundwater extraction rate of 100 gpm, and an average groundwater concentration of 1.4 mg/l (VOC and SVOC), it is estimated that an average of 784 g/day (1.7 lbs/day) total VOC/SVOC would be removed by the groundwater treatment system. Assuming an air flow rate of 90 CFM, and an average air-phase VOC concentration (calculated from soil concentration) of 1.6×10^{-6} lb/ft^3, it is estimated that an average of 0.2 lbs/day VOC would be removed by the SVE treatment system.

The residuals remaining after treatment under Alternative 5 would include organic constituents concentrated in spent carbon from the groundwater GAC system, the SVE GAC system and waste sludge from the inorganics pretreatment system. Handling of these residuals would require properly trained personnel.

Assuming a 100 gpm groundwater extraction rate and using the Calgon model, and a preliminary VOC/SVOC concentration of 1.2 mg/l the theoretical constituent liquid carbon usage was determined to be 0.1 lbs C/1,000 gallons of treated water, or 14.4 lbs per day. Using the same model and groundwater extraction rate, the theoretical vapor-phase carbon usage was determined to be approximately 0.08 lbs C/1,000 gallons of water treated, or 11 lbs/day. The variation in VOC/SVOC concentration from preliminary sizing to final remains within the range of costing accuracy of this report.

Based on an average inorganic concentration of 682 mg/l and an average flow rate of 100 gpm, a preliminary estimate of the sludge generated during operation of the treatment system is as follows:

- raw sludge solids (dry weight): 819 lbs/day
- raw sludge volume: 4,910 gals/day
- dewatered sludge at 35% solids: 2,340 lbs/day

A summary of the carbon usage and sludge generation rates is presented in Appendix C. As shown above, the amount of sludge generated from inorganics pretreatment would be significant and the sludge may be classified as a hazardous waste based on TCLP metals concentrations. Assuming 90 CFM and using the Calgon model, the theoretical constituent vapor-phase carbon usage for the SVE system was determined to be 0.14 lbs/1,000 CFM of vapor-phase treated or 18 lbs per day.

Short-Term Effectiveness - Alternative 5

The evaluation of Short-Term Effectiveness presented below considers, as appropriate, protection of the community and workers during the remedial actions, environmental impacts during the remedial actions, and time until protection is achieved.

The impacts to the community, workers, and the environment during implementation of Alternative 5 would be similar to the impacts associated with Alternative 3, since they both involve construction of caps and installation of a groundwater extraction system. However, additional exposure and environmental risk would potentially result during installation and operation of the SVE and treatment system in the IWS 2 Area.

Exposure due to direct contact with soil and debris and contaminant migration via rainfall infiltration through the unsaturated zone in the capped areas would be eliminated immediately after installation of the caps. The groundwater extraction and treatment system would effectively prevent the further migration of contaminants from the SWDA and IWS Areas immediately upon development of the capture zone. However, there would be no short-term attainment of remediation goals under this or any other alternative. Short-term protectiveness would be accomplished through the implementation of institutional controls. The period of time necessary for the SVE system to reduce VOC levels to clean up goals (that would be based on groundwater protection) within IWS 2 Area cannot be accurately estimated, given difficulties associated with effective implementation of this measure.

The time to implement Alternative 5 is estimated in the following table.

TASK	MONTHS
Predesign Activities	7
Design (Preliminary through Final)	9
Equipment/Material/Contractor Procurement	2
Site Preparation	2

TASK	MONTHS
Construction of Cap/Groundwater Extraction System/Soil Vapor Extraction System	16
Vegetation of Cap	3
Total Estimated Implementation Time (Calendar)	30

Schedule development at this phase of the project must be performed conservatively, and is subject to change based on design parameters and site conditions encountered including climate impacts on field/construction activities. It is possible that this schedule will expand or shrink as more detailed design activities are undertaken.

Implementability - Alternative 5

The implementability evaluation assesses, as appropriate, the ability to construct and operate technologies, the reliability of technologies, the ability to monitor the effectiveness of the remedy, the availability of services and materials, the administrative feasibility, and the availability of off-site TSDFs and capacity.

Implementability considerations associated with cap construction and groundwater extraction and treatment system installation and operation would be the same as those discussed under Alternatives 2 and 3. As discussed under Alternative 4, there would be significant implementability concerns associated with SVE operation within IWS 2, due to the low permeability of soil and presence of buried debris.

Cost Analysis - Alternative 5

The cost sensitivity analysis resulted in the preparation of low-, medium, and high-case cost scenarios for both the capital and operation and maintenance costs of Alternative 5. Assumptions associated with Alternative 5 which were varied include the same assumptions varied for other alternatives involving capping (see Alternative 2), source control groundwater extraction (see Alternative 3) and soil vapor extraction (see Alternative 4).

Estimated costs for the Alternative 5 cost scenarios (medium, high, and low) are presented in the following table (total present worth costs are rounded to the nearest $100,000). Specific numbers utilized in the cost assumptions and factors in the cost sensitivity analysis of 5 are presented on the detailed cost assumptions list in Appendix C. Backup calculations for each alternative are also presented in Appendix C.

Cost Case Scenario	Capital Cost	(30 Years) Annual O&M Cost	(30 Years) Present Worth Annual O&M Cost	(15 Years) Annual O&M Cost	(15 Years) Present Worth Annual O&M Costs at 7%	Present Worth Non-annual O&M Cost	Total Present Worth
5 - Medium	$15,890,000	$1,000,000	$12,410,000	$150,000	$1,370,000	$300,000	$30,000,000
5 - High	$20,690,000	$1,400,000	$17,370,000	$250,000	$2,280,000	$400,000	$40,700,000
5 - Low	$12,350,000	$550,000	$6,820,000	$100,000	$910,000	$300,000	$20,400,000

4.3.6 Alternative 8A: Downgradient Groundwater Extraction Combined with Alternatives 2 or 4 (No Source Control Groundwater Extraction)

Alternative 8A would supplement Alternatives 2: Containment/No Source Control Groundwater Extraction or 4: Containment/In-situ Vapor Extraction of IWS 2/No Source Control Groundwater Extraction with a downgradient groundwater extraction system (MOM System) to contain contaminated groundwater that has been detected downgradient of the SWDA and IWS Areas.

4.3.6.1 Description

Alternative 8A would include the following measures (components that are not also included in Alternatives 2 or 4 are presented in bold type):

- possible temporary relocation of seven mobile homes on the northern side of the SWDA during cap construction activities;
- regrading of the SWDA to achieve appropriate slopes and drainage for cap;
- possible re-routing of a limited portion of the Unnamed Stream beneath or adjacent to the SWDA cap;

- design and installation of a SVE system within IWS 2 (Alternative 4 only);

- long-term (15-year) monitoring and maintenance of the SVE system (only if combined with Alternative 4);

- treatment of air extracted by SVE system by GAC polishing (only if combined with Alternative 4);

- off-site disposal and/or further treatment or destruction of SVE system residuals (only if combined with Alternative 4);

- construction of a composite-barrier (RCRA) cap on the SWDA and IWS 1 Area and separate caps on IWS 2 and 3 Areas;

- installation and operation of active gas collection systems and central gas treatment (flaring) system in SWDA and IWS Areas;

- installation of perimeter storm water ditches and a storm water retention pond to manage the surface runoff from the landfill caps;

- potential waste reconfiguration to minimize wetlands impacts;

- revegetation of the capped areas to control erosion;

- **extraction of groundwater downgradient of the area encompassing the SWDA and IWS Areas at the known southerly extent of the contaminant plume (MOM system);**

- **treatment of extracted groundwater by air stripping and GAC polishing (or an alternative technology that may be selected during the design phase); this treatment requires a pretreatment step consisting of hydroxide/carbonate precipitation to remove inorganics;**

- **piping and discharge of treated groundwater to the Passumpsic River; groundwater would be treated to obtain levels necessary to comply with NPDES program requirements (alternatives to discharging treated water to the Passumpsic River will be evaluated during pre-design);**

- **long-term maintenance, monitoring of the groundwater treatment system.**

- **off-site disposal and/or further treatment or destruction of treatment residuals;**

- institutional controls/deed restrictions to limit intrusive activities in the capped area and prevent use of impacted groundwater;
- construction of a fence around the capped areas to deter unauthorized access;
- long-term groundwater, surface water, and sediment monitoring;
- possible wetlands mitigation, if adversely impacted; and
- five-year review to evaluate the effectiveness of the remedial measure, including engineering review of geosynthetic performance under field conditions.

Groundwater Recovery

The MOM system would consist of approximately three wells screened in the overburden and one well screened in the fractured bedrock (Figure 4-11). In order to ensure that Contaminants of Concern at any elevation in the Lower Proximal unit would be captured, the overburden wells would be screened through the full saturated thickness of that unit. Based upon the capture-zone analyses presented in Appendix F, the overburden wells would be located along a line approximately 1,200 feet west of the SWDA and IWS 1 Area. One of the overburden wells would be located approximately 170 feet east-southeast of monitoring well MW 119. A second overburden well would be located approximately 240 feet south-southwest of MW 131. The third overburden well would be located approximately 210 feet east-northeast of monitoring well MW 120. Each overburden well would be pumped at approximately 30 to 40 gpm each, for a combined total extraction rate for the overburden wells of 100 gpm.

The bedrock well would be located approximately 300 feet north-northeast of the intersection of Lily Pond Road, Red Village Road and Brown Farm Road. This well would be screened in the upper 50 feet of bedrock. Based upon the pumping test conducted in bedrock and the capture-zone analyses presented in Appendix F, a pumping rate of approximately 15 gpm would be necessary for hydraulic control in the fractured bedrock.

Therefore, a total groundwater extraction rate for Alternative 8A of approximately 115 gpm is anticipated.

Groundwater Treatment

The following discussion describes a possible approach for the design of the treatment system utilizing inorganics pretreatment via hydroxide/carbonate precipitation followed by air stripping and GAC polishing. The actual design selected may differ from that presented below and would depend upon further analysis that would be conducted during the design phase.

The following values provide an approximate description of the scale of the inorganics pretreatment equipment which would be used to treat extracted groundwater under Alternative 8A:

- equalization tank: 13,800 gallons
- chemical reaction tanks: 6,900 gallons
- flocculation tanks: 2,300 gal.
- clarifier: 20,700 gal. 230 sq. ft. 17 feet diameter
- pressure filters (3): 3 feet diameter
- backwash pump rate: 115 gpm
- chemical day tank with metering pump (2) 250 gal. ea.
- sludge thickening and dewatering equipment.

Following inorganics pretreatment, groundwater would flow through an air stripper four feet in diameter and 20 feet tall. Groundwater then would be treated with an activated carbon polish. At an estimated flow rate of 115 gpm an EBCT of approximately 15 minutes per carbon unit, the GAC system would consist of two canisters (allowing for 20 percent bed expansion during backwash) which are approximately 10 feet tall, 6.5 feet in diameter, and each containing approximately 8,000 pounds of granular activated carbon (depending on the specific gravity of the carbon used). Air effluent would be treated with an activated carbon polish. Vapor-phase carbon units would consist of one vessel, with two beds, each three feet deep and containing approximately 6,000 pounds of carbon. However, there are many standard units on the market, and ready-made carbon units which would approximate treatment requirements could be used.

Soil Vapor Extraction

The SVE system installed under Alternative 8 would be identical to that installed for Alternative 4. The soil vapor extraction area would encompass the IWS 2 Area. For the preliminary planning purpose of the FS, it is assumed that extracted soil vapor would be treated with vapor-phase GAC. During the design phase, alternative methods would be evaluated. Evaluation and selection of potential extraction and injection configurations would be conducted during predesign activities. Soil vapor probes would be installed to monitor the effectiveness of the remediation

Predesign Studies

The predesign studies that would be performed to support design and implementation of Alternative 8A would include those identified for Alternatives 2 and 4 as well as additional predesign investigations to support the design of the MOM system, as follows:

- the studies necessary to support cap construction (see Alternative 2 description);
- the studies necessary to support implementation of a SVE and treatment measure, if included (see Alternative 4);
- the studies necessary to support the design of the groundwater treatment system (see Alternative 3); and
- an additional pumping test performed between wells 119 and 131 to evaluate extraction rates, capture zone development, potential wetlands impacts, and potential groundwater concentrations associated with the downgradient system.

4.3.6.2 Alternative 8A - Detailed Evaluation

The following discussion presents the detailed evaluation for Alternative 8A.

Overall Protection of Human Health and the Environment - Alternative 8A

The evaluation of the Overall Protection of Human Health and the Environment presented below includes consideration of human health protection (with respect to the potential for direct contact with soil and debris and groundwater ingestion), and environmental protection (wetlands effects and groundwater effects).

The human health protection provided under Alternative 8A would be similar to that offered by Alternatives 2 or 4 alone. Capping and deed restrictions would prevent direct contact with soil and debris that may contain Contaminants of Concern and minimize impacts to wetlands in the adjacent stream. The risk of exposure to groundwater via ingestion would be addressed by enforcement of institutional controls preventing groundwater use in the impacted area. As previously discussed, residences within the area where groundwater containing Contaminants of Concern have been detected are currently, or have the option of being connected to the village of Lyndonville's municipal water system.

The downgradient extraction system would prevent movement of groundwater containing constituents above remediation goals beyond the known limits of migration. If combined with either Alternative 2 or 4, contaminants would continue to migrate from the SWDA and IWS Areas in groundwater but would be captured by the downgradient withdrawal wells. Groundwater concentration reductions would occur within the area contained by the extraction system due to the effects of the caps and the downgradient groundwater extraction system; however, levels in the impacted area may remain above remediation goals. The timeframe for reduction of levels to remediation goals within the contained area is not predictable within the foreseeable future. Figures 4-12 and 4-13 show the predicted cone of influence and estimated capture zone for Alternative 8A, respectively.

The expected cone of influence that would be developed by the MOM system pumping with no source control pumping would have a radius of influence of approximately 1,000 feet. The drawdown in the wetlands areas would be in the range of 1.0 to 1.8 feet. The maximum drawdown (1.8 feet) would occur along the Unnamed Stream, 500 to 600 feet east of Riverside School. The groundwater elevation in the Lower Proximal in the vicinity of Riverside School is approximately 11 feet below the elevation of the Unnamed Stream. Piezometer data presented in the RI report confirm that this portion of the Unnamed Stream is a losing stream. Given the large separation from the water table, the stream is likely under gravity drainage, especially under low flow conditions. Therefore, a 1.0 to 1.8 foot change in the water table would not affect the stream loss rate. North and northeast of IWS 2, the wetlands are developed in the Upper Proximal and Distal units. Because the Distal unit acts as a semi-confining layer, pumping in the Lower Proximal unit is expected to have little or no affect upon those wetland areas.

The physical impacts to wetlands would be primarily associated with filling as a result of cap construction (see comments for Alternative 2). The design of the caps for the SWDA and IWS Areas will include a storm water system including a detention pond which could incorporate wetlands mitigation. The presence of caps over the SWDA and IWS Areas would reduce or eliminate the infiltration of rainwater and, in turn, the development and migration of leachate into adjacent wetlands. Surface runoff of rain or snowmelt would also remain uncontaminated as it would migrate through or over clean, vegetated fill, also minimizing impacts to wetlands. A maintained vegetative cover minimizes erosion and sedimentation to the Unnamed Stream or Passumpsic River. Wetlands mitigation options will be incorporated in the detailed design based on the amount of wetlands actually impacted.

The installation and operation of an in-situ soil vapor extraction system within IWS 2, if included in this alternative, would have no impact on the downgradient extraction system or length of time it would operate. The cap alone would isolate the unsaturated zone in IWS 2. Furthermore, as previously discussed, the concentrations of Contaminants of Concern in IWS 2 groundwater are 1.5 to 2 orders of magnitude lower than observed in the groundwater in other IWS Areas, and IWS 2, therefore does not appear to be a significant source of groundwater contamination.

Compliance with ARARs - Alternative 8A

Table 4-4 summarizes ARARs for Alternative 8A (Downgradient Groundwater Extraction/Combined with Alternatives 2 or 4). The ARARs compliance scenario for Alternative

8A is essentially the same as that for Alternative 2 or 4, depending on which alternative it is combined with, and also includes as ARARs the Vermont Water Quality Standards and the National Pollutant Discharge Elimination System.

Long-Term Effectiveness and Permanence - Alternative 8A

The evaluation of Long-Term Effectiveness and Permanence presented below considers, as appropriate, the magnitude of residual risk and adequacy and reliability of controls. An assessment of the long-term impact of this alternative on groundwater is also included.

Implementation of Alternative 8A would not significantly reduce the residual risk associated with the SWDA and IWS Areas, since either of the containment alternatives that Alternative 8A might be combined with would by themselves prevent direct exposure to soil and debris within these areas. Implementation of institutional controls to prevent ingestion of impacted groundwater, would address the risk of potential exposure to impacted groundwater.

The downgradient extraction system would prevent the further migration of groundwater beyond the known extent of groundwater contamination. Within the area contained by the extraction system, constituent levels may remain above remediation goals, although they would be reduced due to the effect of the caps and groundwater flushing, dispersion and natural degradation processes. The timeframe to reduce constituent levels to remediation goals within this area cannot be determined and is unpredictable for the foreseeable future, because the rate at which source materials that may be in direct contact with groundwater would deplete cannot be determined. Therefore, the long-term effectiveness of this alternative, with respect to potential exposure to groundwater, will result primarily from the implementation of institutional controls.

Groundwater extraction systems have been proven reliable for the containment of contaminated groundwater; therefore, the downgradient extraction system should reliably prevent the movement of groundwater containing Contaminants of Concern above remediation goals beyond the capture zone of the system. Similarly, the treatment and discharge systems should function reliably. For the reliability of controls included in the capping measures, see the evaluation of Alternatives 2.

Implementation of SVE in IWS 2 would have minimal impact on groundwater quality, since source materials in the unsaturated zone within IWS 2 would be isolated by the cap alone. Furthermore, RI data indicate that source material in the IWS 2 Area is not significantly impacting groundwater.

Reduction of Toxicity, Mobility or Volume - Alternative 8A

The evaluation of Reduction of Toxicity, Mobility, or Volume Through Treatment presented below considers, as appropriate, the treatment processes and materials treated, the amount of hazardous materials destroyed or treated, the degree of expected reduction in TMV, the degree to which treatment reduces the inherent hazards posed by principal threats at the site, the degree to which treatment is irreversible, and the type and quantity of residuals remaining after treatment.

Groundwater extracted by the MOM system would be pretreated via hydroxide/carbonate precipitation followed by air stripping and GAC polishing (or an alternative technology that may be selected during the design phase). Under Alternative 8A, assuming an average groundwater extraction rate of 115 gpm, and an average groundwater concentration of 0.66 mg/l (VOC/SVOC), it is estimated that an average of 413 g/day (0.9 lbs/day), total VOC/SVOC would be removed by the treatment system.

Vapor extracted by the SVE system would be treated by vapor-phase carbon (or alternative technology that may be selected during the design phase). Assuming an average air flow rate into the treatment system of 90 CFM, and an average vapor-phase concentration (calculated from soil concentrations) of 1.6×10^{-6} E-6 lb/ft^3 VOC, it is estimated that an average of 0.2 lbs/day total VOC would be removed by the treatment system.

The degree of expected reduction in TMV cannot be determined, because the total mass of Contaminants of Concern within the area encompassed by the SWDA and IWS Areas cannot be accurately calculated. Similarly, the degree to which treatment would reduce the inherent hazard posed by Contaminants of Concern in the SWDA and IWS Areas cannot be reliably estimated; however, this reduction would be minimal, since the human health and environmental risk associated with Contaminants of Concern in the SWDA and IWS Areas would be primarily controlled through capping and institutional controls. For example, removal of VOC via vapor extraction from IWS 2 materials would not significantly reduce the risk posed by these materials, since the cap alone would isolate the unsaturated zone within IWS 2. Although groundwater extraction and treatment would remove toxicity from the groundwater, the timeframe for reduction of levels in groundwater within the area encompassed by the SWDA and IWS Areas is unpredictable within the foreseeable future. Therefore, the risk of exposure to groundwater will be primarily controlled through implementation of institutional restrictions on groundwater use.

Residuals remaining after groundwater treatment would include organic constituents concentrated in spent carbon and inorganic constituents concentrated in sludge from the inorganics pretreatment system. Using the Calgon model, and assuming 115 gpm extraction rate the theoretical constituent vapor-phase carbon usage for downgradient pumping was determined to be 0.08 lbs C/1,000 gallons of treated water or 12 lbs per day, and the liquid-phase carbon usage was determined to be 0.1 lbs/1,000 gallons of treated water or 16.6 lbs/day.[3] Based on an average inorganic concentration of 224 mg/l and an average flow rate of 115 gpm, a preliminary estimate of the sludge generated under Alternative 8A is as follows:

- raw sludge solids (dry weight): 309 lbs/day
- raw sludge volume: 1,855 gal/day
- dewatered sludge at 35% solids: 884 lbs/day

As shown above, the amount of sludge generated from inorganics pretreatment would be significant and the sludge may be classified as a hazardous waste based on TCLP metals concentrations. Analysis of sludge will be required to determine appropriate disposal methods.

Residuals remaining after SVE treatment would include organic constituents concentrated in spent carbon. Using the Calgon model and assuming an air flow rate of 90 CFM the theoretical

[3] Carbon usage rate modeling was based on a preliminary VOC/SVOC concentration of 1.23 mg/l. Final concentration determination yielded 1.44 mg/l VOC/SVOC. This resultant variation of carbon use falls well within the degree of acceptable costing accuracy of this report.

constituent for vapor carbon usage for SVE was determined to be 0.14 lbs/1,000 CFM of treated vapor-phase or 18 lbs/day.

As with all of the alternatives involving groundwater treatment, the toxicity of Contaminants of Concern in extracted groundwater would be permanently reduced through treatment; however, the overall toxicity would not be reduced, since the constituents would simply be transferred to another medium, which would require treatment or disposal. Handling of contaminants would require properly trained personnel.

Short-Term Effectiveness - Alternative 8A

The evaluation of Short-Term Effectiveness presented below considers, as appropriate, protection of the community and workers during the remedial actions, environmental impacts during the remedial actions, and time until protection is achieved.

The potential risks to workers and the community and environmental impacts during implementation of Alternative 8A would similar to those described under Alternatives 2 or 4 (depending on whether or not a SVE system is included).

The beneficial results of most of the measures implemented under Alternative 8A would occur upon their implementation. Capping of the SWDA and IWS Areas would prevent direct contact with and contaminant migration via infiltration through soil and debris. There would be no short-term attainment of groundwater remediation goals under this or any other alternative. However, short-term protectiveness would be accomplished through institutional controls. The downgradient groundwater extraction and treatment system would be effective shortly after installation, once the capture zone associated with groundwater extraction is established. However, if an SVE system is implemented, the period of time necessary for the SVE system to reduce VOC levels to clean up goals (that would be based on groundwater protection) within IWS 2 cannot be accurately estimated, given the implementation difficulties associated with effective SVE operation within IWS 2. The estimated time to implement Alternative 8A is presented in the following table.

TASK	MONTHS
Predesign Studies	7
Design	9
Equipment Procurement	2
Site Preparation	2
Construction of Cap/Installation of SVE System if included/Downgradient Groundwater Extraction and Treatment System Installation	16
Vegetation of Cap	3
Total Estimated Implementation Time (Calendar)	30

Schedule development at this phase of the project must be performed conservatively, and is subject to change based on design parameters and site conditions encountered including climate impacts on field/construction activities. It is possible that this schedule will expand or shrink as more detailed design activities are undertaken.

Implementability - Alternative 8A

The implementability evaluation presented below considers, as appropriate, the ability to construct and operate technologies, the reliability of technologies, the ability to monitor the effectiveness of the remedy, the availability of services and materials, the administrative feasibility, the availability of off-site TSDFs and capacity, and the availability of prospective technologies.

The implementability issues associated with installation of the caps and groundwater extraction/treatment/discharge system and institutional controls discussed in the evaluations for source control alternatives would apply to Alternative 8A, except that the extraction system would be located away from the SWDA and IWS Areas. Implementability concerns associated with effective SVE system operation discussed under Alternatives 4 and 5 would apply if SVE is included in this alternative.

Cost Analysis - Alternative 8A

Since Alternative 8A would be combined with a capping alternative or a capping and SVE system at IWS 2 alternative, the cost sensitivity analysis evaluated Alternative 8A in combination with Alternatives 2 and 4. Please refer to the appropriate sections to review assumptions that were varied associated with the source control components. Additional assumption variations that resulted in capital, operation, and maintenance cost variations pertaining to Alternative 8A include:

- the groundwater extraction rate, which influences the mass loading rate, system sizing and treatment system operation requirements and materials generation;
- the frequency of treated groundwater discharge and treatment system sampling and analysis;
- the amount and cost of equipment replacement;
- the extent of the wetlands mitigation program, if necessary; and
- whether SVE and treatment was performed; and
- the frequency of monitoring/sampling and the number of wells in the monitoring/sampling program.

Specific numbers utilized in the cost assumptions and factors in the cost sensitivity analysis of Alternative 8A are presented on the detailed cost assumptions lists in Appendix C. Estimated costs for Alternative 8A cost scenarios (medium, high, and low) are presented in the following table (total present worth costs are is rounded to the nearest $100,000). Backup calculations are also included in Appendix C.

Cost Case Scenario	Capital Cost	(30 Years) Annual O&M Cost	(30 Years) Present Worth Annual O&M Cost at 7%	(15 Years) Annual O&M Costs	(15 Years) Present Worth Annual O&M Cost at 7%	Present Worth Nonannual O&M Cost	Total Present Worth
8A - Medium	$16,110,000	$850,000	$10,550,000	$150,000	$1,370,000	$350,000	$28,400,000
8A - High	$20,860,000	$1,250,000	$15,510,000	$250,000	$2,280,000	$400,000	$39,100,000
8A - Low	$12,270,000	$500,000	$6,200,000	$0	$0	$300,000	$18,800,000

4.3.7 Alternative 8B: Downgradient Groundwater Extraction Combined with Alternatives 3 or 5 (Source Control Groundwater Extraction)

Alternative 8B would supplement Alternative 3: Containment/Source Control Groundwater Extraction or Alternative 5: Containment/In-Situ Soil Vapor Extraction of IWS 2/Source Control Groundwater Extraction with a downgradient groundwater extraction system (MOM System) to contain contaminated groundwater that has been detected downgradient of the SWDA and IWS Areas.

4.3.7.1 Description

Alternative 8B would include the following measures (components that are not also included in Alternatives 3 or 5 are presented in bold type):

- possible temporary relocation of seven mobile homes on the northern side of the SWDA during cap construction activities;
- regrading of the SWDA to achieve appropriate slopes and drainage for the cap;
- possible re-routing of a limited portion of the Unnamed Stream beneath or adjacent to the SWDA cap;
- construction of a composite-barrier (RCRA) cap on the SWDA and IWS 1 Area and separate RCRA caps on the IWS 2 and 3 Areas;
- potential relocation of waste to minimize wetlands impacts;

- installation and operation of an active gas collection system and central gas treatment (flaring) system in SWDA and IWS Areas;
- installation of perimeter storm water ditches and a storm water retention pond to manage the surface runoff from the caps;
- design and installation of a SVE system within IWS 2 (only if combined with Alternative 5);
- long-term (15-year) monitoring and maintenance of the SVE system (only if combined with Alternative 5);
- treatment of extracted air from the SVE system by GAC polishing (only if combined with Alternative 5);
- off-site disposal and/or further treatment or destruction of the SVE system residuals (only if combined with Alternative 5);
- revegetation of the capped areas to control erosion;
- extraction of groundwater to prevent the off-site flow of groundwater that contains concentrations exceeding the remediation goals;
- **extraction of groundwater downgradient of the area encompassing the SWDA and IWS Areas at the known southerly extent of the contaminant plume;**
- treatment of extracted groundwater by air stripping and GAC polishing (or an alternative technology that may be selected during the design phase); this treatment requires a pretreatment step consisting of hydroxide/carbonate precipitation to remove inorganics;
- piping and discharge of treated groundwater to the Passumpsic River (alternatives to discharging treated water to the Passumpsic River will be evaluated during pre-design);
- long-term maintenance, monitoring of the groundwater treatment system;
- off-site disposal and/or further treatment or destruction of treatment residuals;
- institutional controls/deed restrictions to limit intrusive activities in the capped area and prevent use of impacted groundwater;

- construction of a fence around the capped areas to deter unauthorized access;
- long-term groundwater, surface water, and sediment monitoring;
- possible wetlands mitigation, if adversely impacted; and
- five-year review to evaluate the effectiveness of the remedial measure, including engineering review of geosynthetic performance under field conditions.

Groundwater Recovery

The source-control portion of this alternative is identical to the system described under Alternative 3. Approximately five wells would be required in the overburden and one well in the fractured bedrock to achieve hydraulic control of the sources (Figure 4-14). In order to ensure that Contaminants of Concern at any elevation in the Lower Proximal unit would be captured, the overburden wells would be screened through the full saturated thickness of that unit. Based upon the capture-zone analyses presented in Appendix F, the overburden wells would each be located on a line downgradient of IWS 1 and IWS 2, at spacings of 250 to 280 feet. These wells would each be pumped at between 19 gpm and 25 gpm, or at a combined rate of approximately 85 gpm. One additional overburden well would be located approximately 150 feet southwest of monitoring well 131. This well would be pumped at approximately 30 gpm. The bedrock well would be located in the upper 50 feet of bedrock, just downgradient of IWS 2. Based upon the pumping-test conducted in bedrock and the capture-zone analyses presented in Appendix F, a pumping rate of approximately 15 gpm would be necessary for hydraulic control in the fractured bedrock.

The MOM portion of this alternative would consist of one well screened in the overburden and one well screened in the fractured bedrock. In order to ensure that Contaminants of Concern at any elevation in the Lower Proximal unit would be captured, the overburden well would be screened through the full saturated thickness of that unit. Based upon the capture-zone analyses presented in Appendix F, the overburden well would be located approximately 150 feet southwest of monitoring well 131 (Figure 4-14). Because the overburden MOM well would be operating in conjunction with the source control wells, the pumping rate would be approximately 30 gpm.

The MOM bedrock well would be located approximately 300 feet north-northeast of the intersection of Lily Pond Road, Red Village Road and Brown Farm Road. This well would be screened in the upper 50 feet of bedrock. Based upon the pump-test conducted in bedrock and the capture-zone analyses presented in Appendix F, a pumping rate of approximately 15 gpm would be necessary for hydraulic control in the fractured bedrock.

Based on the above, a total combined source control and MOM system extraction rate of 145 gpm is estimated.

Groundwater Treatment

The following discussion describes a possible approach for the design of the treatment system utilizing inorganics pretreatment via hydroxide/carbonate precipitation followed by air stripping and GAC polishing.

The sizing of the inorganics pretreatment system was varied in the cost sensitivity analysis. The following values provide an approximate description of the scale of the inorganics pretreatment equipment which would be used to treat extracted groundwater under Alternative 8B:

- equalization tanks: 17,400 gallons
- chemical reaction tanks: 8,700 gallons
- flocculation tanks: 2,900 gal.
- clarifier: 26,100 gal. 290 sq. ft. 19 feet diameter
- pressure filters (3): 3 feet diameter
- backwash pump rate: 145 gpm
- chemical day tanks: (2) at 250 gal each
- sludge thickening and disposal systems.

Following inorganics pretreatment, groundwater would flow through an air stripper 4 feet in diameter and 20 feet tall. Groundwater then would be treated with an activated carbon polish. At an estimated flow rate of 45 gpm an EBCT of approximately 15 minutes per carbon unit, the GAC system would consist of three canisters (allowing for 20 percent bed expansion during backwash) which are approximately 10 feet tall, 6.5 feet in diameter, and each containing approximately 8,000 pounds of granular activated carbon (depending on the specific gravity of the carbon used). Air effluent would be treated with an activated carbon polish. Vapor-phase carbon units would consist of one vessel, with two beds, each three feet deep and containing approximately 6,000 pounds of carbon. However, there are many standard units on the market, and ready-made carbon units which would approximate treatment requirements could be used.

Soil Vapor Extraction

The SVE system installed under Alternative 5 would be identical to that installed for Alternative 4. The soil vapor extraction area would encompass the IWS 2 Area. For the preliminary planning purpose of the FS, it is assumed that extracted soil vapor would be treated with vapor-phase GAC. During the design phase, alternative methods would be evaluated. Evaluation and selection of potential extraction and injection configurations would be conducted during predesign activities. Soil vapor probes would be installed to monitor the effectiveness of the remediation.

Predesign Studies

The predesign studies that would be performed to support design and implementation of Alternative 8B would include:

- the studies necessary to support cap construction (see Alternative 2 description);
- the studies necessary to support design and implementation of a source control groundwater extraction measure, if included (see descriptions of Alternatives 3 and 5);

- the studies necessary to support implementation of a SVE and treatment measure, if included (see Alternative 5); and

- an additional pumping test would be performed near monitoring well MW 131 to evaluate extraction rates, capture zone development, potential groundwater influent concentrations, and potential wetlands impacts associated with the downgradient system.

4.3.7.2 Alternative 8B - Detailed Evaluation

The following discussion presents the detailed evaluation for Alternative 8B.

Overall Protection of Human Health and the Environment - Alternative 8B

The evaluation of the Overall Protection of Human Health and the Environment presented below includes consideration of human health protection (with respect to the potential for direct contact with soil and debris and groundwater ingestion), and environmental protection (wetlands effects and groundwater effects).

Under Alternative 8B, as with all of the other alternatives except for No Action, capping would prevent direct contact with soil and debris in the SWDA and IWS Areas, and minimize impacts of sediment on adjacent wetlands. The risk of exposure to groundwater via ingestion would be addressed by implementation of institutional controls. As previously discussed, the residences within the affected area are currently, or have the option of being, connected to the Village of Lyndonville's municipal water supply.

The caps would reduce the contaminant mass loading rate to the treatment system by eliminating the migration of constituents from the unsaturated zone in the SWDA and IWS Areas via rainfall infiltration. The source control groundwater extraction system would effectively intercept the flow of contaminated groundwater from the area encompassing the SWDA and IWS Areas 1, 2, and 3. The downgradient extraction system would prevent movement of groundwater containing constituents above remediation goals beyond the known limits of migration.

However, groundwater concentrations within the SWDA and IWS Areas may remain above remediation goals. The degree of groundwater quality improvement and the timeframe for reduction of levels to remediation goals within the SWDA and IWS Areas is not predictable within the foreseeable future. Groundwater concentrations beyond the area encompassed by the SWDA and IWS Areas would not reach remediation goals for approximately 60 years. The MOM system would have negligible effect on the time to achieve groundwater remediation goals downgradient of the source control extraction system. Figures 4-15 and 4-16 show the predicted cone of influence and approximate capture zone for Alternative 8B, respectively.

Wetlands impacts (adverse and beneficial) associated with construction of the cap would be the same as those described under Alternative 2. Operation of the extraction systems is not expected to impact wetlands, because drawdown effects are not expected to propagate through the Distal to the upper portions of the Unnamed Stream. The lower portions of the Unnamed Stream are separated from the Lower Proximal by 11 to 15 feet, and the water table lowering resulting from pumping is expected to be minimal.

The installation and operation of an in-situ soil vapor extraction system within IWS 2, if included in this alternative, would have no impact on the source control or downgradient extraction systems or length of time they would operate. As previously discussed, the concentrations of Contaminants of Concern in IWS 2 groundwater are 1.5 to 2 orders of magnitude lower than observed in the groundwater in other IWS Areas, and IWS 2, therefore does not appear to be a significant source of groundwater contamination. Furthermore, the majority of waste material within IWS 2 is located within the unsaturated zone and therefore, the potential for contaminants to migrate would effectively be eliminated through the construction of a RCRA type cap over this area.

Compliance with ARARs - Alternative 8B

Table 4-3 summarizes ARARs for Alternative 8B (Downgradient Groundwater Extraction/Combined with Alternatives 3 or 5). The ARARs compliance scenario for Alternative 8B is essentially the same as that for Alternative 3 or 5.

Long-Term Effectiveness and Permanence - Alternative 8B

The evaluation of Long-term Effectiveness and Permanence presented below considers, as appropriate, the magnitude of residual risk and adequacy and reliability of controls. An assessment of the long-term impact of this alternative on groundwater is also included.

Implementation of the downgradient extraction system under Alternative 8B would not significantly reduce the residual risk associated with the SWDA and IWS Areas, since both of the source control alternatives that Alternative 8B might be combined with would include a cap to prevent direct exposure to soil and debris within the SWDA and IWS Areas, and institutional controls to prevent ingestion of impacted groundwater.

Because there may continue to be source areas within the saturated zone within the area encompassed by the SWDA and IWS Areas, concentrations of Contaminants of Concern within this area could remain greater than the remediation goals but would be reduced by groundwater flushing, dispersion and natural degradation. Because the mass of Contaminants of Concern that may be present in the saturated zone cannot be determined, the degree of groundwater quality improvement and the timeframe for reduction of levels in groundwater to remediation goals within the SWDA and IWS Areas is not predictable within the foreseeable future. Therefore, the potential for ingestion of groundwater within this area will be addressed in the long-term through institutional controls.

The long-term effectiveness of this alternative, with respect to potential exposure to groundwater downgradient of the source control extraction system, would also result from implementation of institutional controls, since under this alternative, groundwater concentrations of the indicator compound TCE downgradient of the source control system would not reach remediation goals for approximately 60 years. The calculation of time to achieve concentration reductions used an adaptation of the mixed linear reservoir or "batch flush" model (EPA, 1988b; 1988c). As noted in the model documentation, the methodology results in log/linear function of concentration and time. The function is dependent upon the starting concentrations and the soil-water partitioning coefficients (K_d) of the organic compounds. The starting concentrations were estimated by using the highest concentration of the compound detected in any monitoring well located downgradient of the source control wells. The K_d values were calculated from published K_{ow} or K_{oc} values for each compound detected.

In addition to the reduction in groundwater migration offered by either of the source control measures that would be implemented in conjunction with Alternative 8B (see the evaluation of Alternatives 3 and 5 for description and evaluation of these reductions), the downgradient extraction system would also contain the known downgradient limits of groundwater containing Contaminants of Concern.

Groundwater extraction systems have been proven reliable for the containment of contaminated groundwater; therefore, the downgradient extraction system should reliably prevent the movement of groundwater containing Contaminants of Concern above remediation goals beyond the capture zone of the system. Similarly, the treatment and discharge systems should function reliably. For the reliability of controls included in source control measures that may be combined with Alternative 8B, see the evaluations for those alternatives.

Reduction of Toxicity, Mobility, or Volume - Alternative 8B

The evaluation of Reduction of Toxicity, Mobility, or Volume Through Treatment presented below considers, as appropriate, the treatment processes and materials treated, the amount of hazardous materials destroyed or treated, the degree of expected reduction in TMV, the degree to which treatment reduces the inherent hazards posed by principal threats at the site, the degree to which treatment is irreversible, and the type and quantity of residuals remaining after treatment.

Groundwater extracted by the source control and downgradient systems would be treated via hydroxide/carbonate precipitation followed by air stripping and GAC polishing (or an alternative technology that may be selected during the design phase). Under Alternative 8B, assuming an average flow rate into the treatment system of 145 gpm, and an average groundwater concentration of 1.1 mg/l (VOC/SVOC), it is estimated that an average of 879 g/day (1.9 lbs/day) total VOC/SVOC would be removed by the treatment system.

The degree of expected reduction in TMV cannot be determined, because the total mass of Contaminants of Concern within the SWDA and IWS Areas cannot be accurately calculated. Similarly, the degree to which treatment would reduce the inherent hazard posed by Contaminants of Concern in the SWDA and IWS Areas cannot be reliably estimated; however, this reduction would be minimal, since the human health and environmental risk associated with Contaminants of Concern in the SWDA and IWS Areas would be primarily controlled through capping and institutional controls. For example, removal of VOC via vapor extraction from IWS 2 materials would not significantly reduce the risk posed by these materials, since the cap alone would isolate the unsaturated zone within IWS 2. Although groundwater extraction and treatment would remove toxicity from the groundwater, the timeframe for reduction of levels in groundwater within the area encompassing the SWDA and IWS Areas is unpredictable within the foreseeable future. Downgradient of the source control extraction system, groundwater standards would not be reached for approximately 60 years. Therefore, the risk of exposure to groundwater will be primarily controlled through implementation of institutional restrictions on groundwater use.

As with all of the alternatives involving groundwater treatment, the toxicity of Contaminants of Concern in extracted groundwater would be permanently reduced through treatment; however, the overall toxicity would not be reduced, since the constituents would simply be transferred to another medium, which would require treatment or disposal.

Residuals remaining after groundwater treatment would include organic constituents concentrated in spent carbon and inorganic constituents concentrated in sludge from the inorganics pretreatment system. Using the Calgon model, the theoretical constituent liquid-phase carbon usage for downgradient pumping was determined to be 0.1 lbs C/1,000 gallons of treated water or 21 lbs per day and the theoretical constituent vapor-phase carbon usage for downgradient pumping was determined to be 0.08 lbs/1,000 gallons of treated water or 16 lbs/day.[4] Based on an average inorganic concentration of 590 mg/l and an average flow rate of 145 gpm, a preliminary estimate of the sludge generated under Alternative 8B is as follows:

[4] Carbon usage rate modeling was based on a preliminary VOC/SVOC concentration of 12.3 mg/l. Final concentration determination yielded 1.44 mg/l VOC/SVOC. This resultant variation of carbon use falls well within the degree of acceptable costing accuracy of this report.

- raw sludge solids (dry weight): 1,027 lbs/day
- raw sludge volume: 6,160 gal/day
- dewatered sludge at 35% solid: 2,935 lbs/day

As shown above, the amount of sludge generated from inorganics pretreatment would be significant and the sludge may be classified as a hazardous waste based on TCLP metals concentrations. Sampling and analysis of sludge will be required to determine appropriate disposal methods. Residuals remaining after SVE treatment would include organic constituents concentrated in spent carbon. Using the Calgon model and assuming an average air flow rate of 90 CFM, the vapor-phase carbon usage for SVE system was determined to be 0.14 lbs/1,000 CFM or 18 lbs/day.

Short-Term Effectiveness - Alternative 8B

The evaluation of Short-Term Effectiveness presented below considers, as appropriate, protection of the community and workers during the remedial actions, environmental impacts during the remedial actions, and time until protection is achieved.

The potential risks to workers, community and the environment during implementation of Alternative 8B would primarily be associated with the source control measure that is performed (see short-term effectiveness evaluations for Alternative 3). Adverse environmental impacts during installation and start-up of the downgradient extraction/treatment/discharge system would be minimal. Drawdown effects from the groundwater pumping system upon wetlands would also be minimized by either the 11 to 15 foot separation between the Unnamed Stream and the water table, or the separation of the Unnamed Stream from the Lower Proximal by the Distal. The treated groundwater extraction system discharges are expected to equal approximately 1 percent of the stream flow of the Passumpsic River and therefore, are expected to have minimal impact upon stream flow and quality.

The beneficial results of most of the measures that may be implemented under Alternative 8B would occur upon their implementation. Capping of the SWDA and IWS Areas would prevent direct contact with and contaminant migration via infiltration through soil and debris.

Institutional controls preventing ingestion of impacted groundwater would address this potential exposure risk immediately upon implementation. The source control and downgradient groundwater extraction systems would be effective shortly after their installation, once the capture zones associated with the systems are established. However, if a SVE system is implemented, VOC levels within IWS 2 materials may not reach clean up levels (that would be based on groundwater protection) for an indefinite time period, given the implementation difficulties associated with effective SVE operation with IWS 2.

The estimated time to implement Alternative 8A is presented in the following table.

TASK	MONTHS
Predesign Studies	7
Design	9
Equipment Procurement	2
Site Preparation	2
Construction of Cap/Installation of SVE System, if included/Source Control and Downgradient Groundwater Extraction and Treatment Systems Installation	16
Vegetation of Cap	3
Total Estimated Implementation Time (Calendar)	30

Schedule development at this phase of the project must be performed conservatively, and is subject to change based on design parameters and site conditions encountered including climate impacts on field/construction activities. It is possible that this schedule will expand or shrink as more detailed design activities are undertaken.

<u>Implementability - Alternative 8B</u>

The implementability evaluation presented below considers the ability to construct and operate technologies, the reliability of technologies, the ability to monitor the effectiveness of the remedy, the availability of services and materials, the administrative feasibility, the availability of off-site TSDFs and capacity, and the availability of prospective technologies.

The implementability issues associated with the cap and groundwater extraction/treatment/discharge system discussed in the evaluations for source control alternatives would apply to Alternative 8B as well (see implementability evaluations for Alternative 3). Implementability concerns associated with effective SVE system operation discussed under Alternatives 4 and 5 would apply if SVE is included in this alternative.

Cost Analysis - Alternative 8B

Since Alternative 8B could be combined with a source control alternative(s), the cost sensitivity analysis evaluated Alternative 8B in combination with alternatives 3 (low case) or 5 (medium and high case). Additional assumption variations that resulted in capital, operation, and maintenance cost variations pertaining to Alternative 8B include:

- the downgradient aquifer pump test(s) number and duration;
- the groundwater extraction rate, which influence the mass loading rate and treatment system operation requirements and materials generation;
- the groundwater extraction and treatment system(s) sizing;
- whether SVE would be performed in IWS 2;
- the extent of the wetlands mitigation program; and
- extent of predesign studies.

Specific numbers utilized in the cost assumptions and factors in the cost sensitivity analysis of Alternative 8B are presented on the detailed cost assumptions lists in Appendix C. Estimated costs for Alternative 8B cost scenarios (medium, high, and low) are presented in the following table (total present worth costs are rounded to the nearest $100,000). Backup calculations are included in Appendix C.

Cost Case Scenario	Capital Cost	(30 Years) Annual O&M Cost	(30 Years) Present Worth Annual O&M Cost at 7%	(15 Years) Annual O&M Cost	(15 Years) Present Worth Annual O&M Cost at 7%	Present Worth Nonannual O&M Cost	Total Present Worth
8B - Medium	$17,130,000	$1,100,000	$13,650,000	$150,000	$1,370,000	$350,000	$32,500,000
8B - High	$22,010,000	$1,500,000	$18,610,000	$250,000	$2,280,000	$450,000	$43,400,000
8B - Low	$13,130,000	$650,000	$8,070,000	$0	$0	$300,000	$21,500,000

5.0 COMPARATIVE ANALYSIS

This section presents the comparative analysis of the potential remedial alternatives. The comparison is based on the nine evaluation criteria presented in Section 4. The discussion in Section 5.1 identifies and describes the strengths and weaknesses of the alternatives relative to one another with respect to each criterion. Section 5.2 presents a comparative analysis summary.

5.1 COMPARATIVE ANALYSIS - EVALUATION CRITERIA

Overall Protection of Human Health and the Environment

The evaluation of the Overall Protection of Human Health and the Environment includes consideration of human health protection (with respect to the potential for direct contact with soil and debris and groundwater ingestion), and environmental protection (wetlands effects and groundwater effects).

All of the alternatives except for the No Action Alternative provide a similar level of human health protection with respect to the potential for direct contact with soil and solid waste material, since they all include the construction of caps and deed restrictions to protect cap integrity. There would be some potential short-term risk of exposure to soil and solid waste material during cap construction and any demolition debris relocation under all of these alternatives. There would be a greater level of potential short-term risk to workers associated with Alternatives 4 and 5, since they would also involve construction of a soil vapor extraction system in IWS 2.

All of the alternatives, except for "No Action", would include institutional controls to prevent the ingestion of groundwater that may pose a health risk. Cooperation from the State, municipality and the public are required to implement these controls. Residences downgradient of the SWDA and IWS Areas where Contaminants of Concern have been detected are currently, or have the option of being connected to the Village of Lyndonville's municipal water supply.

Implementation of capping measures alone, without a groundwater extraction measure (Alternative 2), would effectively eliminate the migration of constituents via infiltration from SWDA and IWS Area sources located above the water table, and therefore would result in an improvement in downgradient groundwater quality. The extent to which potential source materials in the saturated zone may continue to impact groundwater cannot be determined. Therefore, the degree of groundwater quality improvement and timeframe for reduction of levels to remediation goals is unpredictable within the foreseeable future.

If a source control groundwater extraction measure was also included (Alternatives 3, 5 and 8B), there would be only a small improvement in overall human health protectiveness relative to Alternative 2, since protection would be accomplished through institutional controls for approximately 60 years (downgradient of the extraction system) or more (within the SWDA and IWS Areas). Under Alternatives 3 and 5, the migration of impacted groundwater from the SWDA and IWS Areas would be prevented and additional improvement in downgradient groundwater quality would occur. However, the timeframe for reduction of levels in groundwater within the area contained by the source control extraction system is unpredictable within the foreseeable future. Groundwater standards would not be reached downgradient of the source control groundwater extraction system for approximately 60 years after the system was in place.

Implementation of a downgradient extraction system (Alternatives 8A and 8B) would contain the known downgradient extent of the contaminant plume but would not accelerate the reduction of constituent levels in impacted groundwater. Under Alternative 8A, constituent levels would reduce within the area contained by the downgradient extraction system due to the effects of the caps and groundwater flushing, dispersion and natural degradation, although the time period to reach groundwater standards would be unpredictable and cannot be calculated. Under 8B, the timeframe to reduce levels in groundwater to remediation goals within the SWDA and IWS Areas would be unpredictable within the foreseeable future, and groundwater between the source control and downgradient extraction systems would not reach drinking water standards for the same (approximately 60 year) time period as that calculated assuming implementation of a source control extraction system alone. Installation and operation of a soil vapor extraction system within IWS 2 (Alternatives 4 and 5) would not significantly reduce human health risks or impacts to groundwater, since the cap alone would prevent migration of constituents from the unsaturated zone within IWS 2.

The physical impacts to wetlands under Alternatives 2 through 8 would be similar, and would be primarily associated with filling as a result of cap construction. The design of the caps for the SWDA and IWS Areas may incorporate waste reconfiguration to minimize wetlands impacts and will include a storm water control system including a detention pond which could incorporate wetlands mitigation after establishment of vegetative cover on the cap system. Wetlands mitigation actions will be evaluated as part of the detailed design once the amount of active wetlands impact is determined.

The presence of caps over the SWDA and IWS Areas would reduce or eliminate the infiltration of rainwater and, in turn, the development and migration of leachate into adjacent wetlands. Surface runoff of rain or snowmelt would also remain uncontaminated as it would migrate through or over clean, vegetated fill. Erosion and sediment impacts would also be minimized due to the presence of the maintained, vegetated caps. Therefore, under all of the alternatives which incorporate a cap (Alternatives 2, 3, 4, 5 and 8) there would be a reduction of erosion and sedimentation impacts to the stream and sediment relative to Alternative 1.

Compliance with ARARs

Alternative 1 (No Action) generally does not comply with chemical-, action-, or location-specific ARARs. In contrast, Alternative 2 will meet both action-specific and location-specific ARARs and portions of chemical-specific ARARs. However, this alternative will not comply with federal or state groundwater standards, such as the maximum permissible concentrations of hazardous constituents in groundwater established by the state or the federal MCLs, for Contaminants of Concern. Tables 4-1 through 4-4 provide a synopsis of these requirements.

For any of the alternatives, concentrations of Contaminants of Concern may remain above groundwater standards within the SWDA and IWS Areas for an unpredictable timeframe, although for Alternatives 2 through 8, the levels would reduce due to the effects of the caps and groundwater flushing, dispersion, and natural degradation processes. Alternatives 3, 5, and 8B include a source control groundwater extraction system. Even with the source control groundwater extraction system, groundwater concentrations of Contaminants of Concern downgradient at the point of compliance and beyond are estimated to take approximately 60 years, following installation and start-up, to meet ARARs for these alternatives.

Similar to Alternative 2, Alternatives 3 through 8 also comply with action- and location-specific ARARs. Tables 4-5, 4-6 and 4-7 summarize the ARARs and the affected alternatives for chemical-, action-, and location-specific ARARs, respectively.

Long-Term Effectiveness and Permanence

The evaluation of Long-Term Effectiveness and Permanence considers, as appropriate, the magnitude of residual risk, and adequacy and reliably of controls. An assessment of the long-term impact of this alternative on groundwater is also included in this FS.

The magnitude of residual risk associated with the potential for direct contact with Contaminants of Concern in soil and debris would be similar under Alternatives 2, 3, 4, 5, and 8 because they include a cap. Cap systems are proven, in general, to perform reliably in the long-term. Alternative 1 would not address the potential for exposure to Contaminants of Concern in soil and debris.

Although there would be some improvement in groundwater quality associated with cap installation under any of the alternatives (except for Alternative 1), the degree of groundwater quality improvement and time to achieve groundwater standards beneath the SWDA and IWS Areas is not predictable for the foreseeable future under any of the alternatives. Under alternatives including a source control groundwater extraction system (Alternatives 3, 5 and 8b), a remediation timeframe can be calculated for groundwater downgradient of the source control extraction system, since the extraction system would prevent the movement of contaminated groundwater beyond the SWDA and IWS Areas and allow downgradient groundwater levels to reduce at a predictable rate. However, calculations indicate that levels within this area would not reduce to groundwater standards for approximately 60 years after a system was in place, even if a downgradient extraction system is included. Therefore, in the long term, under any of the alternatives except for No Action, protectiveness would be achieved primarily through institutional controls preventing groundwater use. Institutional controls can perform reliably in the long-term, although they require the cooperation of the State, municipality and the public. Residences downgradient of the SWDA and IWS Areas where Contaminants of Concern have been detected are currently, or have the option of being connected to the Village of Lyndonville's municipal water supply.

Although there have been effectiveness problems associated with the use of extraction and treatment systems for aquifer remediation, extraction systems have been used reliably as containment systems which hydraulically prevent contaminant migration. The source control extraction treatment system would need to remain in operation for an indeterminant time period (beyond 60 years) to maintain downgradient groundwater quality improvement. Extraction well fouling can be addressed by routine maintenance and monitoring. The groundwater treatment system would generate considerable amounts of residual materials, as compared to the Contaminants of Concern treated, which would require off-site treatment or disposal.

The operation of an SVE system in IWS 2 would not significantly improve the long-term effectiveness of remedial measures relative to other Alternatives that include a cap (Alternatives 2, 3 and 8 without SVE). The caps, under Alternatives 2, 3, 4, 5 and 8 would reliably prevent direct contact with and leaching from Contaminants of Concern within the unsaturated zone in IWS 2. Even under current conditions, waste materials within the unsaturated zone in IWS 2 do not appear to be significantly impacting groundwater. The long-term effectiveness of the SVE system may be limited due to the presence of low permeability soils and the presence of debris, which could cause VOC removal along preferential pathways and leave contaminants in high concentration areas. Some VOC would be permanently removed from soil at IWS 2;

however, residual material from the operation of the SVE system would require off-site treatment or disposal.

Reduction of Toxicity, Mobility, and Volume through Treatment

The evaluation of Reduction of Toxicity, Mobility, or Volume (TMV) through treatment considers, as appropriate, the treatment processes and materials treated, the amount of hazardous materials destroyed or treated, the degree of expected reduction in TMV, the degree to which treatment reduces the inherent hazards posed by principal threats at the site, the degree to which treatment is irreversible, and the type and quantity of residuals remaining after treatment.

The degree of expected reduction in TMV cannot be calculated for any of the alternatives because the total contaminant mass associated with source materials within the SWDA and IWS Areas cannot be accurately determined. Similarly, the degree to which treatment would reduce the inherent hazard posed by Contaminants of Concern in the SWDA and IWS Areas cannot be reliably estimated; however, this reduction would be minimal, since the human health and environmental risk associated with Contaminants of Concern in the SWDA and IWS Areas would be primarily controlled through capping and institutional controls. For example, removal of VOC via vapor extraction from IWS 2 materials would not significantly reduce the risk posed by these materials, since the cap alone would isolate the unsaturated zone within IWS 2. Although groundwater extraction and treatment under Alternatives 3, 5 and 8 would remove toxicity from the groundwater, the timeframe for reduction of levels in groundwater within the SWDA and IWS Areas is unpredictable within the foreseeable future. Downgradient of the extraction system, groundwater standards would not be reached for approximately 60 years. Therefore, the risk of exposure to groundwater will be primarily controlled through implementation of institutional restrictions on groundwater use.

Under Alternative 2, although groundwater quality would improve, the toxicity of Contaminants of Concern would not be reduced through treatment, and treatment residuals would not be generated. Under Alternatives 3, 5, and 8, the toxicity of Contaminants of Concern in extracted groundwater would be reduced through treatment for organic constituents using air stripping/GAC and for inorganics using hydroxide/carbonate precipitation. However, they would transfer that toxicity to spent carbon and inorganics sludge treatment residuals which would then require appropriate treatment/disposal.

Alternatives 3 and 5 would remove approximately 1.7 lbs/day (0.32 tons/year) of total VOC/SVOC and 819 lbs/day (150 tons/year) inorganics from the groundwater. They would also generate approximately 14.4 lbs/day spent liquid carbon, 11 lbs/day spent vapor carbon (a total of 4.6 tons/year spent carbon) and 2,340 lbs/day (427 tons/year) dewatered metal sludge. These treatment residuals would require appropriate handling, perhaps as hazardous material, and off-site disposal. Under Alternative 8B, approximately 1.9 lbs/day (0.35 tons/year) total VOC/SVOC and 1027 lbs/day (187 tons/year) inorganics would be removed. The volume of treatment residual generated would be approximately 20.88 lbs/day spent liquid carbon, 16 lbs/day spent vapor carbon (a total of 36.98 lbs/day or 6.7 tons/year spent carbon) and 2,935 lbs/day (536 tons/year) dewatered metal sludge. Under Alternative 8A, approximately 0.9 lbs/day (0.2 tons/year) total VOC/SVOC and 309 lbs/day (56 tons/year) inorganics would be removed and 16.6 lbs/day spent liquid carbon, 12 lbs/day (5 tons/year) spent vapor carbon and 884 lbs/day (161 tons/year) dewatered metal sludge would be generated.

Alternative 4, and the medium and high-case cost scenarios for 8A and 8B, would include VOC removal from unsaturated soils of IWS 2. Assuming an average air flow rate of 90 CFM, approximately 0.2 lbs/day (0.03 tons/year) total VOC would be removed. They would also generate approximately 18 lbs/day (3 tons/year) of spent vapor carbon. These treatment residuals would require appropriate handling by trained personnel and off-site disposal and/or further treatment or destruction.

Short-Term Effectiveness

The evaluation of Short-Term Effectiveness considers, as appropriate, protection of the community and workers during the remedial actions, environmental impacts during the remedial actions, and time until protection is achieved.

Alternative 1 (No Action) would pose the lowest potential risk to the community and workers during remedial action implementation. Potential short-term risks associated with Alternatives 2, 3, and 8 would be small, and would be primarily associated with construction of the cap and any relocation of demolition debris, and for alternatives involving extraction and treatment of groundwater construction of the discharge pipeline to the Passumpsic River. Alternatives 4 and 5 would pose a greater potential short-term exposure risk, since they would also involve construction of an in-situ SVE system within IWS 2.

Under all of the alternatives except for Alternative 1, wetlands would be impacted in the northern portion where a portion of the Unnamed Stream may be routed through a culvert beneath the cap or relocated adjacent to the SWDA cap. However, the design of the caps for the SWDA and IWS Areas would include a storm water system, including a detention pond, which could incorporate wetlands mitigation. Additional wetlands mitigation investigations will be incorporated into the detailed design, utilizing accurate determinations of actual wetlands affected by cap construction. Predicted water table lowering in wetlands areas induced by groundwater extraction is expected to be small because of the separation of the water table and wetlands systems, and therefore impacts to the wetlands that would be due to groundwater pumping (Alternatives 3, 5, and 8b) are anticipated to be minimal. Environmental impacts during remedial measure implementation would be primarily associated with cap construction and site regrading (all alternatives except for Alternative 1). Construction methodology will incorporate process operations, construction scheduling and environmental controls designed to minimize these impacts.

Protection would not be achieved by Alternative 1, since exposure to soil and debris that may pose a health risk would not be prevented. Under Alternatives 2 through 8, protection would be achieved in the short and long term, primarily through capping and institutional controls. The potential for exposure to soil and solid waste that may contain Contaminants of Concern under Alternatives 2 through 8 would be eliminated immediately after construction of the cap. After installation, the cap would also prevent the migration of constituents from the unsaturated zone due to rainfall infiltration. There will be no short-term attainment of groundwater remedial goals with any alternative. Under Alternative 2, there should be some short-term improvement in groundwater quality compared to the No Action alternative, due to the presence of the impermeable cap; however, the rate and magnitude of this improvement cannot be accurately estimated. Alternatives 3, 5 and 8b should provide some additional short-term reduction of contaminant levels as compared to other alternatives, due to the operation of groundwater extraction and treatment systems; however, groundwater remediation goals would not be attained in the short-term. Short-term protectiveness, with respect to exposure to groundwater under Alternatives 2, 3, 4, 5 and 8, would be achieved through the implementation of institutional controls preventing impacted groundwater use.

The reduction of VOC levels to clean up goals (that would be based on groundwater protection) within IWS 2 under Alternatives 4 and 5 would take an indefinite time period of SVE operation, given difficulties associated with effective implementation of this measure.

The implementation time for Alternative 1 would be minimal, since the No Action alternative only involves performing a five-year site review. It has been estimated that Alternative 2 would take approximately 24 months to implement, and Alternative 4 would take approximately 27 months. The estimated implementation time for the remaining alternatives is approximately 34 months.

<u>Implementability</u>

The implementability evaluation considers, as appropriate, the ability to construct and operate technologies, the reliability of technologies, the ability to monitor the effectiveness of the remedy, the availability of services and materials, the administrative feasibility, and the availability and capacity of off-site TSDFs.

Alternative 1 would be the easiest to implement, since it would only involve performing a five year site review. Construction and maintenance of the caps under Alternatives 2 through 8 could be implemented without significant difficulty, as services and materials are available. The cap design would address the required separation distance between the top of the cap and the high-tension utility lines traversing the SWDA. Caps have been demonstrated to be reliable at many sites. Periodic inspections of the caps to ensure that they continue to effectively prevent direct contact with soil and solid waste containing Contaminants of Concern that may pose a health risk would be necessary. Groundwater monitoring and institutional controls, also included in Alternatives 2 through 8, could be easily implemented. Groundwater monitoring is ongoing and could be continued. Institutional controls would be readily implemented since a public water supply is available to the impacted area, although the cooperation of landowners, the Town, and the State of Vermont would be required.

Installation and operation of the extraction wells, treatment system, and discharge pipeline to the Passumpsic River would utilize standard construction services, techniques, and materials, which would be available. Measures would need to be taken to minimize the potential for remobilization of subsurface nonaqueous-phase contaminants during well installation and pumping. The presence of metals and other inorganic compounds in groundwater would adversely affect the performance of the air stripping/GAC system. Therefore, pretreatment to remove inorganics would be necessary. Precipitation of inorganic materials via hydroxide/carbonate formation is adequate for most groundwater pretreatment requirements. Initial calculations of the potential discharge limits for some metals based on available attenuation of the Passumpsic River showed values which may be difficult to technically attain. Treatability testing and bioassay analysis, combined with outfall modeling will be utilized to determine appropriate water quality criteria and technical feasibility of maintaining effluent limits. Air stripping followed by GAC is a reliable water treatment technology even with variations in groundwater flow and concentrations. Appropriate handling and disposal of groundwater treatment system residuals, including spent carbon from the GAC system and waste sludge from the inorganics pretreatment system, would be necessary. Easements would be required for construction of the discharge pipeline, and compliance with substantive requirements of the NPDES program would be necessary for discharge of the treated groundwater to the Passumpsic River. Procurement of the easements prior to construction may take approximately 12 months. Removal and treatment of residual materials from operation of the groundwater treatment system would require properly trained personnel. Treatment residuals would require off-site disposal.

Vacuum extraction systems have been implemented at other sites. However, SVE may be difficult to implement successfully in IWS 2. Due to the low permeability of soil and presence of buried debris in IWS 2, it may be difficult to achieve adequate and/or homogeneous air flow. Differences in flow rates across the material can cause VOC constituents to be eliminated sporadically, with high concentrations remaining in lower permeability zones. Differences in flow rates can also cause a pressure differential to form across the blower, resulting in a high operating temperature and associated increased operating costs. Removal and treatment of residual materials from operation of the SVE treatment system would require properly trained personnel. Treatment residuals from the SVE system would require off-site disposal.

As discussed above, Alternatives 3, 4, 5, and 8 would involve the off-site disposal of treatment residuals. The nearest lined hazardous waste disposal facilities are located in New York, Ohio, Indiana, and Maine. Waste transportation to these facilities can be expensive, and some of these landfills also have restrictions in accepting hazardous waste. The long-term availability of such facilities is uncertain, since only a few have been permitted in recent years; off-site disposal capacity would be needed for a time period that is unpredictable in the foreseeable future.

Cost Analysis

High, medium and low cost estimates were prepared for each alternative in order to assess the impact of changes in costing assumptions. The medium case-cost estimates (based on an intermediate set of assumptions) are presented as follows:

Alternative	Capital Cost	Annual O&M Cost	Present Worth Annual O&M Cost	Present Worth Non-Annual O&M Cost	Total Present Worth
Alternative 1 Medium Case	$0	$0	$0	$43,000	$40,000
Alternative 2 Medium Case	$11,600,000	$150,000	$1,860,000	$150,000	$13,600,000
Alternative 3 Medium Case	$15,450,000	$1,000,000	$12,410,000	$300,000	$28,200,000

Alternative	Capital Cost	Annual O&M Cost	Present Worth Annual O&M Cost	Present Worth Non-Annual O&M Cost	Total Present Worth
Alternative 4 Medium Case	$12,080,000	$150,000 (30 yr) $150,000 (15 yr)	$1,860,000 (30 yr) $1,370,000 (15 yr)	$150,000	$15,500,000
Alternative 5 Medium Case	$15,890,000	$1,000,000 (30 yr) $150,000 (15 yr)	$12,410,000 (30 yr) $1,370,000 (15 yr)	$300,000	$30,000,000
Alternative 8A Medium Case	$16,110,000	$850,000 (30 yr) $150,000 (15 yr)	$10,550,000 (30 yr) $1,370,000 (15 yr)	$350,000	$28,400,000
Alternative 8B Medium Case	$17,130,000	$1,100,000 (30 yr) $150,000 (15 yr)	$13,650,000 (30 yr) $1,370,000 (15 yr)	$350,000	$32,500,000

The 30-year present worth costs associated with Alternatives 1 through 5 and 8 are compared in the text below.

Alternative 1 would be the least costly to implement ($40,000 to $50,000 total present worth with a medium-case present worth cost estimate of $40,000; total present worth costs are rounded to the nearest $10,000), since it would only involve performing a five-year site review. The estimated total present worth cost to implement Alternative 2 could range from $10,400,000 to $19,300,000, with a medium-case cost estimate of $13,600,000. The costs for this alternative would be principally associated with the construction of caps over the SWDA and IWS Areas. Costs could range from the low to high ends of the cost range depending primarily upon the volume of cap material that is required and whether passive or active gas collection is necessary beneath the caps within the IWS Areas. If in-situ soil vapor extraction within IWS 2 is also included (Alternative 4), this would add $1,000,000 or more to the total present worth cost estimate. The total present worth cost range for Alternative 4 is estimated at $11,800,000 to $22,100,000 (the estimated medium-case present worth cost is $15,500,000). The costs specifically associated with implementation of the SVE system would vary depending on the air flow and mass-loading rates.

The costs associated with the remaining alternatives (Alternatives 3, 5, 8A, and 8B) would be significantly (100% or more) higher because they involve the extraction, treatment, and discharge of groundwater. The range of costs associated with these alternatives are based primarily on varying assumptions regarding the total flow rate and constituents concentrations in groundwater prior to treatment, and also on whether or not in-situ SVE within IWS 2 is included. The estimated total present worth costs for Alternative 3 (capping with source control groundwater extraction) would range from $19,000,000 to $38,000,000, with a medium-case cost estimate of $28,200,000. Alternative 5 (which also includes SVE within IWS 2) low, medium, and high total present worth cost estimates are $20,400,000, $30,000,000 and $40,700,000, respectively. The range of costs associated with Alternative 8A, which includes capping and downgradient groundwater extraction, and possibly also SVE within IWS 2, is $18,800,000 to $39,100,000 (total present worth). The medium-case cost estimate for this alternative is $28,400,000. The low- and medium-case cost estimates for Alternative 8B are $21,500,000 (combined with the low case of Alternative 3) and $32,500,000 (combined with the medium-case of Alternative 5), respectively. The most expensive alternative to construct and operate would be Alternative 8B (capping, downgradient groundwater extraction, and source control groundwater extraction) with in-situ soil vapor extraction within IWS 2. The total present worth costs for this alternative could range up to $43,400,000.

5.2 COMPARATIVE ANALYSIS SUMMARY

The remedial objectives for the Parker Landfill Superfund Project are summarized as follows:

- to minimize, to the extent practicable, the potential for transfer of hazardous substances from the soil and solid waste into the groundwater, surface water, and sediment;
- to prevent direct contact/ingestion of soil or solid waste posing a human health risk;
- to prevent ingestion of groundwater impacted by the Parker Landfill that may pose a human health risk; and
- to comply with federal and state ARARs.

Any of the alternatives involving capping of the SWDA and IWS Areas (Alternatives 2 through 8) would achieve the first two objectives listed above. The cap would minimize the potential for transfer of Contaminants of Concern from the soil and solid waste into the groundwater by preventing rainfall infiltration and migration from the unsaturated zone to groundwater. Capping alternatives would also incorporate drainage and erosion controls. Alternatives involving in-situ soil vapor extraction within IWS 2 (Alternatives 4 and 5), although they would involve significantly increased costs, would not have a significant additional effect on the potential for transfer of constituents to groundwater, since the cap alone would isolate the unsaturated zone. The cap would also prevent direct contact with soil or solid waste within the capped areas. There would be an increased short-term exposure risk associated with installation of the SVE system under Alternatives 4 and 5.

Under any of the alternatives except No Action, protection with respect to exposure to groundwater would be achieved primarily through institutional controls preventing the use of impacted groundwater as a drinking water source. Residents within the known area impacted by groundwater contamination either have access to or are currently connected to the Village of Lyndonville's public drinking water supply.

Although implementation of a groundwater extraction and treatment system in addition to capping and institutional controls (Alternatives 3, 5, 8A and 8B) would result in significantly increased costs over Alternative 2, there would be no short-term attainment of groundwater remediation goals under any alternative. Although implementation of a source control extraction system would prevent migration of Contaminants of Concern beyond the SWDA and IWS Areas, levels in groundwater within the SWDA and IWS Areas may not reduce to remediation goals in the foreseeable future. Downgradient of the extraction wells, groundwater remediation goals would not be met for approximately 60 years. The source control groundwater extraction and treatment system (under Alternatives 3, 5, and 8B) or management of migration system (Alternative 8A) would need to remain in operation for an indeterminant time period (more than 60 years) to maintain downgradient groundwater quality improvement. Regardless of the remedial alternative implemented, the Passumpsic River has not and is not expected to be impacted in the future by Contaminants of Concern from the SWDA or IWS Areas.

REFERENCES

Dennis, John G., 1956, *The Geology of the Lyndonville Area, Vermont*, Vermont Geological Survey, Bulletin, November 8, 1956.

EPA, 1988a, *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA*, OSWER Directive No: 9355.3-01.

EPA, 1988b, *CERCLA Compliance With Other Laws Manual: Interim Final*, OERR, Report No.: EPA/540/G-89/006.

EPA, 1988c, *Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites*, EPA/540/G-88/003, OSWER Directive 9283.1-2, December 1988.

EPA, 1989, *Overview of ARARs Focus on ARARs Waivers, Quick Reference Fact Sheet* Publication 9234.02-03/FS

EPA, 1990, *National Contingency Plan*, 40 CFR 300.5.

EPA, 1991, *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites*, EPA/540/P-91/001, February 1991.

EPA, 1992, *Executive Summary, Draft Baseline Health Risk Assessment*, Parker Landfill Project, May 18, 1992.

EPA, 1993a, *Presumptive Remedies Policy and Procedures*, OSWER Directive 9355.0-47FS, EPA 540-F-93-047, September 1993.

EPA, 1993b, *Presumptive Remedy for CERCLA Municipal Landfill Sites*, OSWER Directive No. 9355.0-49FS, EPA 540-F-93-035, September 1993.

ESE, 1992, *Draft Remedial Investigation Report*, Parker Landfill Project, November 1992.

ESE, 1994, Final Remedial Investigation Report, Parker Landfill Project, January 1994.

Geoservices, Inc., 1988, *Technical Note No. 3 - Freeze-Thaw Effects on CLAYMAX Liner Systems* prepared for James Clem Corp., Chicago, IL.

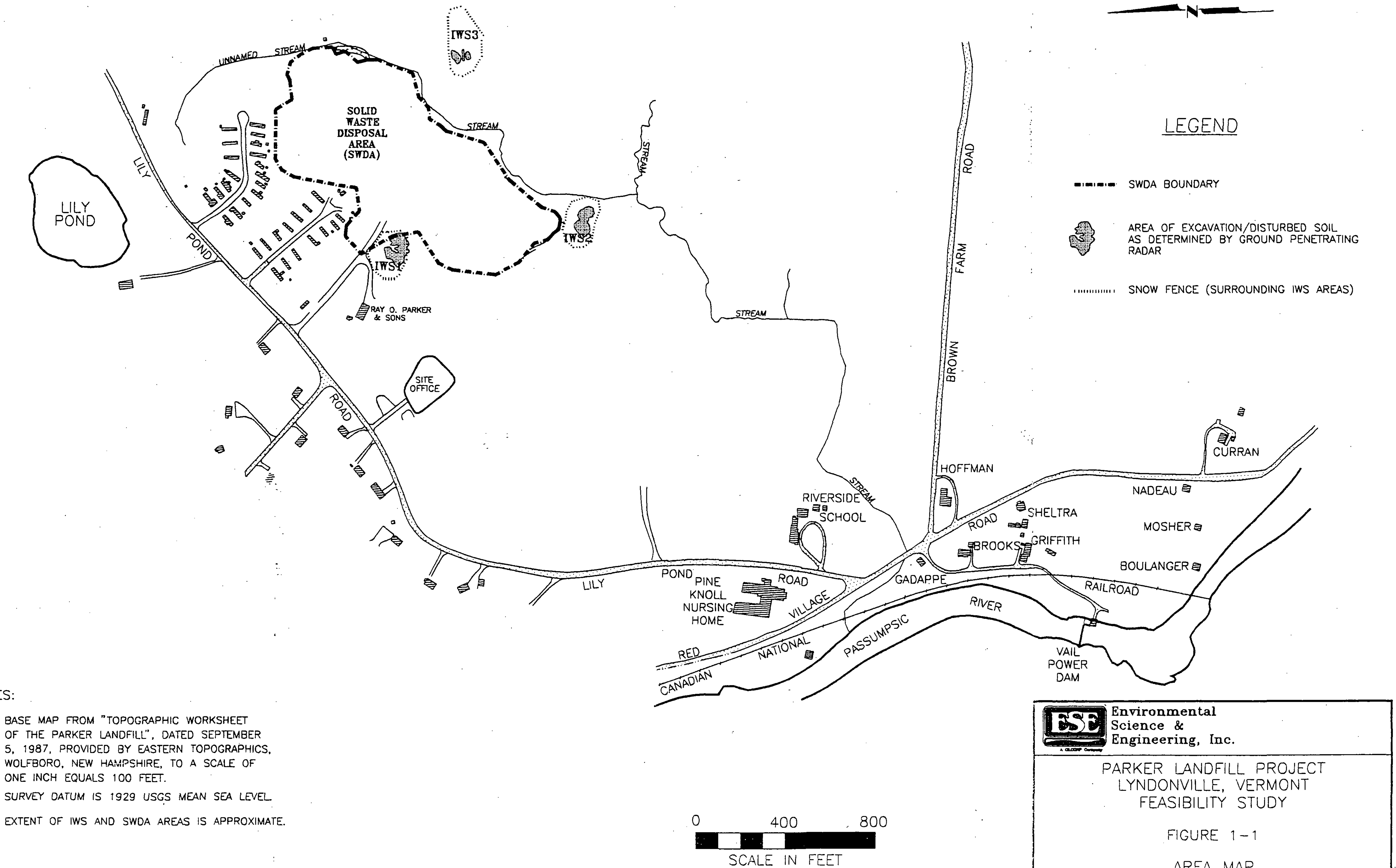
Koerner, Robert M., 1990, *Designing with Geosynthetics, Second Edition, Prentice Hall, Englewood Cliffs, New Jersey.*

VAEC, 1985a, *Preliminary Assessment*, January 1985.

VAEC, 1985b, *Uncontrolled Hazardous Waste Site Evaluation of the Parker Landfill, DRAFT*, February 1985.

Woodland, B.G., 1965, *The Geology of the Burke Quadrangle, Vermont*, Vermont Geological Survey, Bulletin No. 28.

FIGURES



NOTES:

1. BASE MAP FROM "TOPOGRAPHIC WORKSHEET OF THE PARKER LANDFILL", DATED SEPTEMBER 5, 1987, PROVIDED BY EASTERN TOPOGRAPHICS, WOLFBORO, NEW HAMPSHIRE, TO A SCALE OF ONE INCH EQUALS 100 FEET.
2. SURVEY DATUM IS 1929 USGS MEAN SEA LEVEL.
3. EXTENT OF IWS AND SWDA AREAS IS APPROXIMATE.

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LYNDONVILLE, VERMONT
FEASIBILITY STUDY

FIGURE 1-1

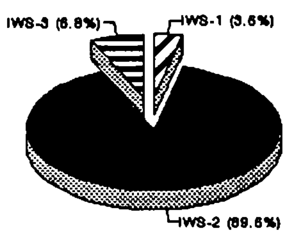
AREA MAP

DRAWING NAME: FSAREA.DWG		FILE NUMBER: 490 5024	
SCALE: AS SHOWN	REVISION: 0	DRAWN BY: PAD	DATE: 1/18/94

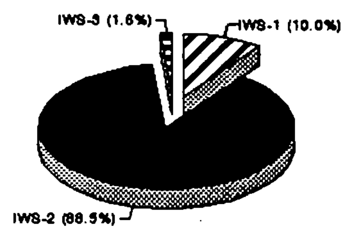
Figure 1-2
Relative Mass of Volatile Organic Compounds in Soils for Different Waste Areas

Parker Landfill Project
Feasibility Study

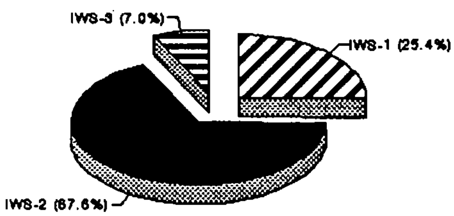
TRICHLOROETHENE



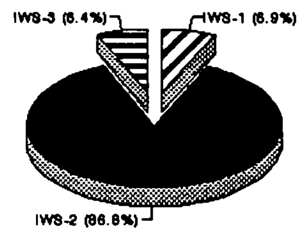
1,2-DICHLOROETHENE



TETRACHLOROETHENE



TOTAL VOC



MEAN CONCENTRATION (mg/kg)

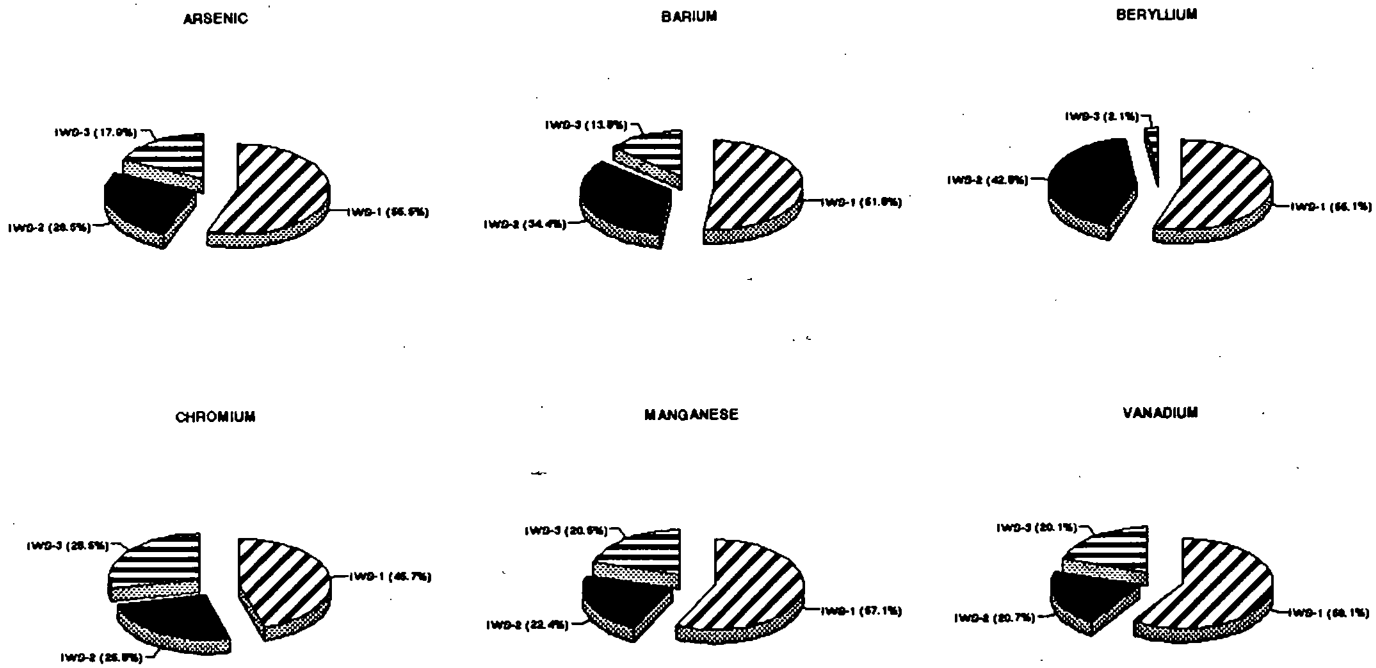
	TCE	1,2-DCE	PERC	TOTAL
IWS-1	3.377	1.650	2.224	8.465
IWS-2	255.008	44.164	17.827	321.695
IWS-3	27.643	1.106	2.628	33.537

MASS (Kg)

	TCE	1,2-DCE	PERC	TOTAL
IWS-1	28	14	18	69
IWS-2	695	120	49	876
IWS-3	53	2	5	64

Figure 1-3
Relative Mass of Inorganic Compounds in Soils for Different Waste Areas

Parker Landfill Project
Feasibility Study



MEAN CONCENTRATION (mg/kg)

	IWS-1	IWS-2	IWS-3
Arsenic	3.7	5.3	5.6
Barium	605.8	1,212.0	751.1
Beryllium	0.07	0.17	0.01
Chromium	583.8	993.5	1,701.6
Manganes	250.2	296.3	419.1
Vanadium	310.4	327.8	493.4

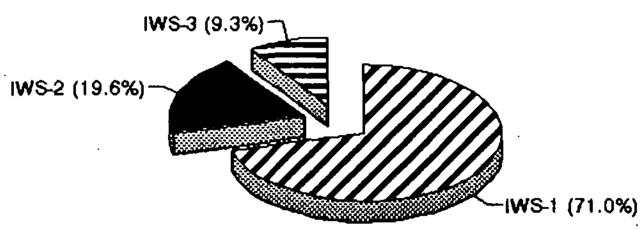
MASS (Kg)

IWS-1	IWS-2	IWS-3
30.3	14.5	9.8
4,970.8	3,301.8	1,320.6
0.59	0.46	0.02
4,790.1	2,706.6	2,991.6
2,052.7	807.3	736.8
2,546.8	892.9	867.4

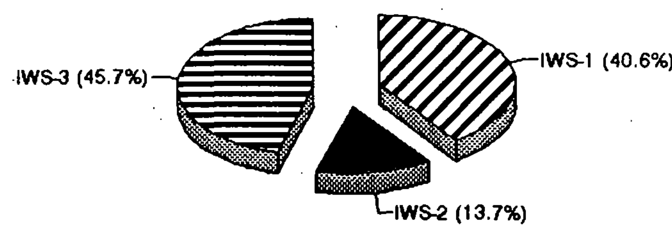
Figure 1-4
Relative Mass of PAH and Semivolatile Organic Compounds in Soils for Different Waste Areas

Parker Landfill Project
Feasibility Study

POLYCYCLIC AROMATIC HYDROCARBONS (PAH)



NON-PAH SEMIVOLATILE ORGANIC COMPOUNDS



	PAH CONC. (mg/kg)	PAH MASS (kg)
IWS-1	5.462	45
IWS-2	4.550	12
IWS-3	3.068	6

NON-PAH CONC. (mg/kg)	NON-PAH MASS (kg)
0.382	3.13
0.388	1.06
1.840	3.53

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FIGURE 2-1

REMEDIAL TECHNOLOGY SCREENING SUMMARY / SWDA AND IWS AREAS

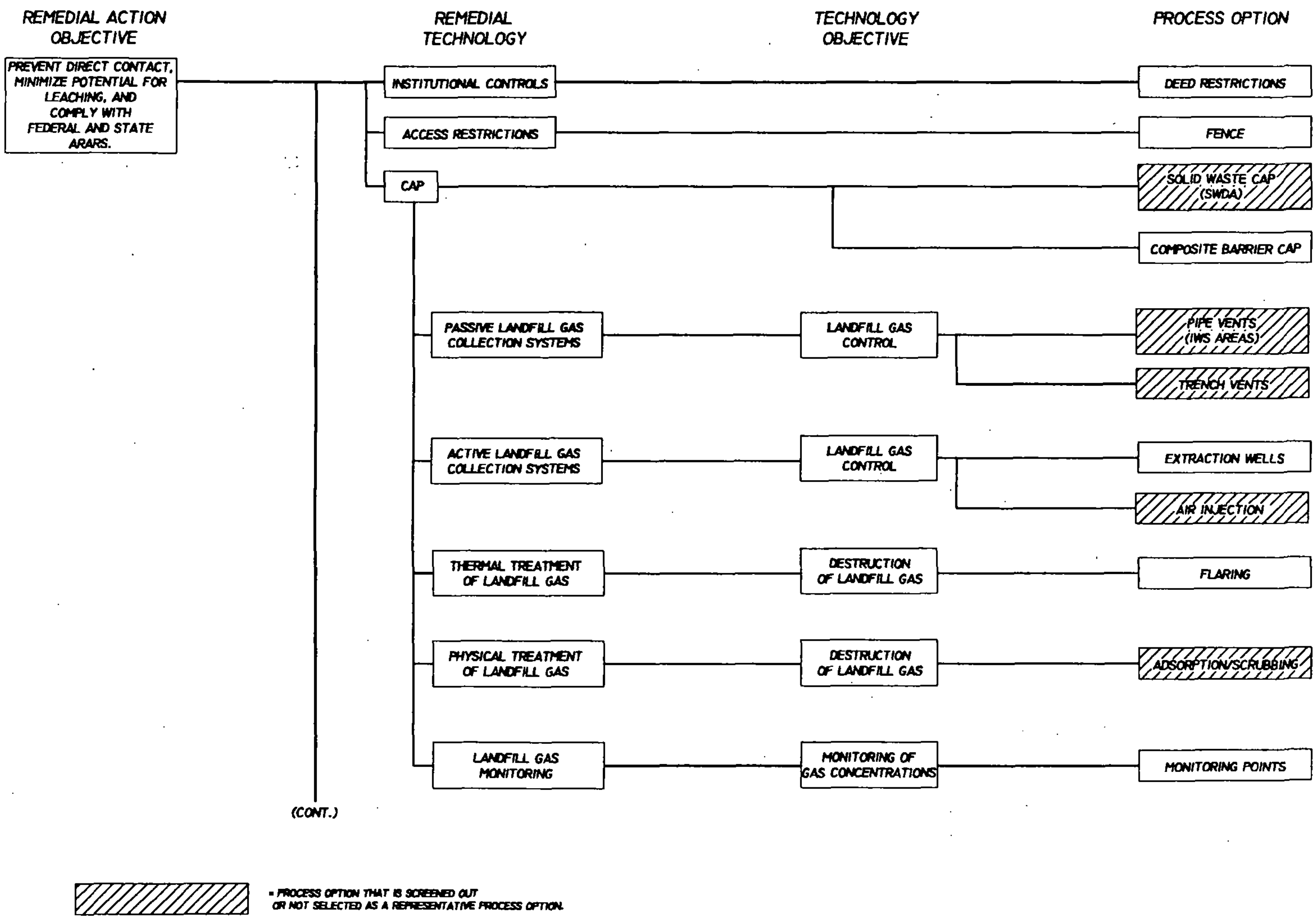

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FIGURE 2-1 (CONT.)

REMEDIAL TECHNOLOGY SCREENING SUMMARY / SWDA AND IWS AREAS

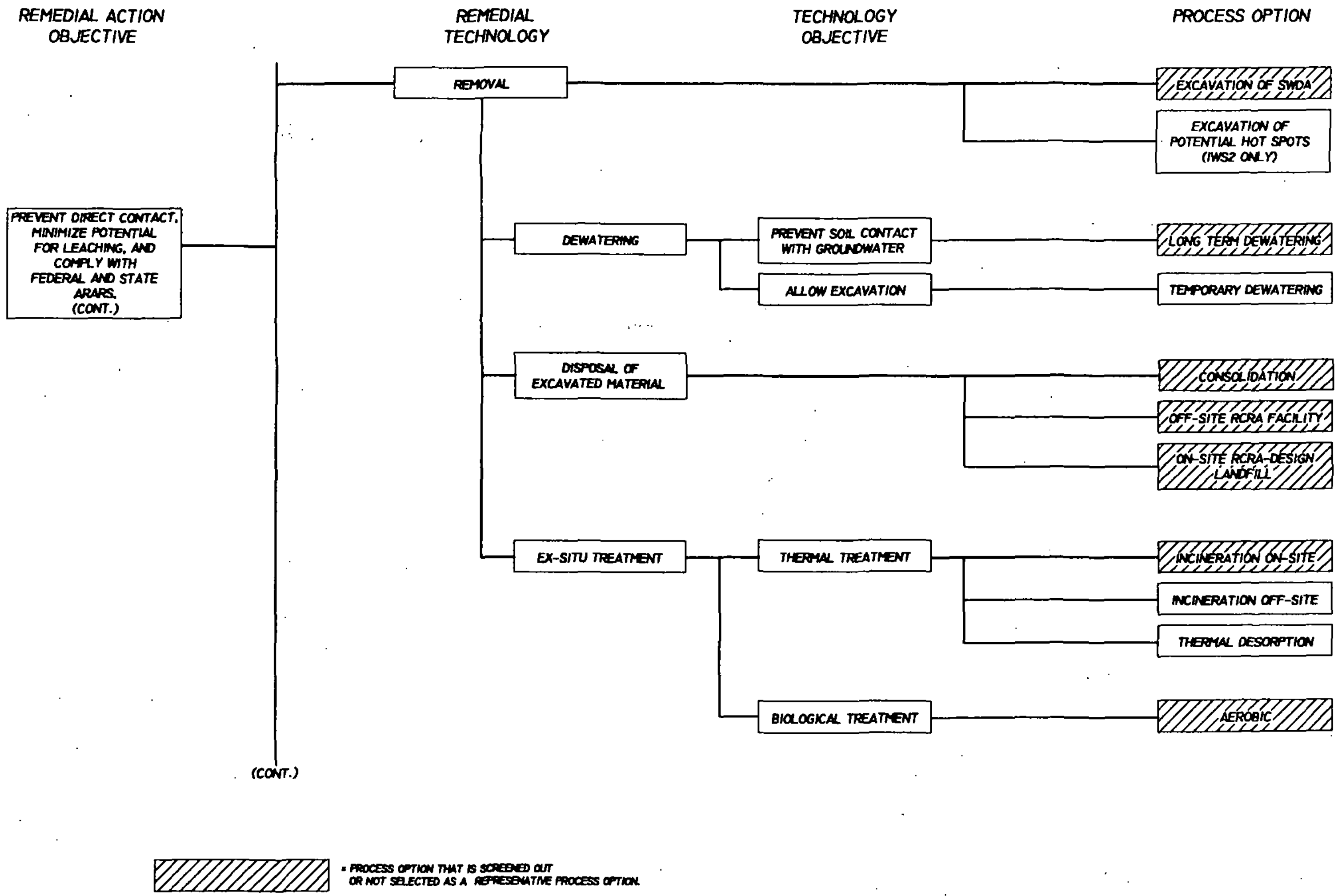

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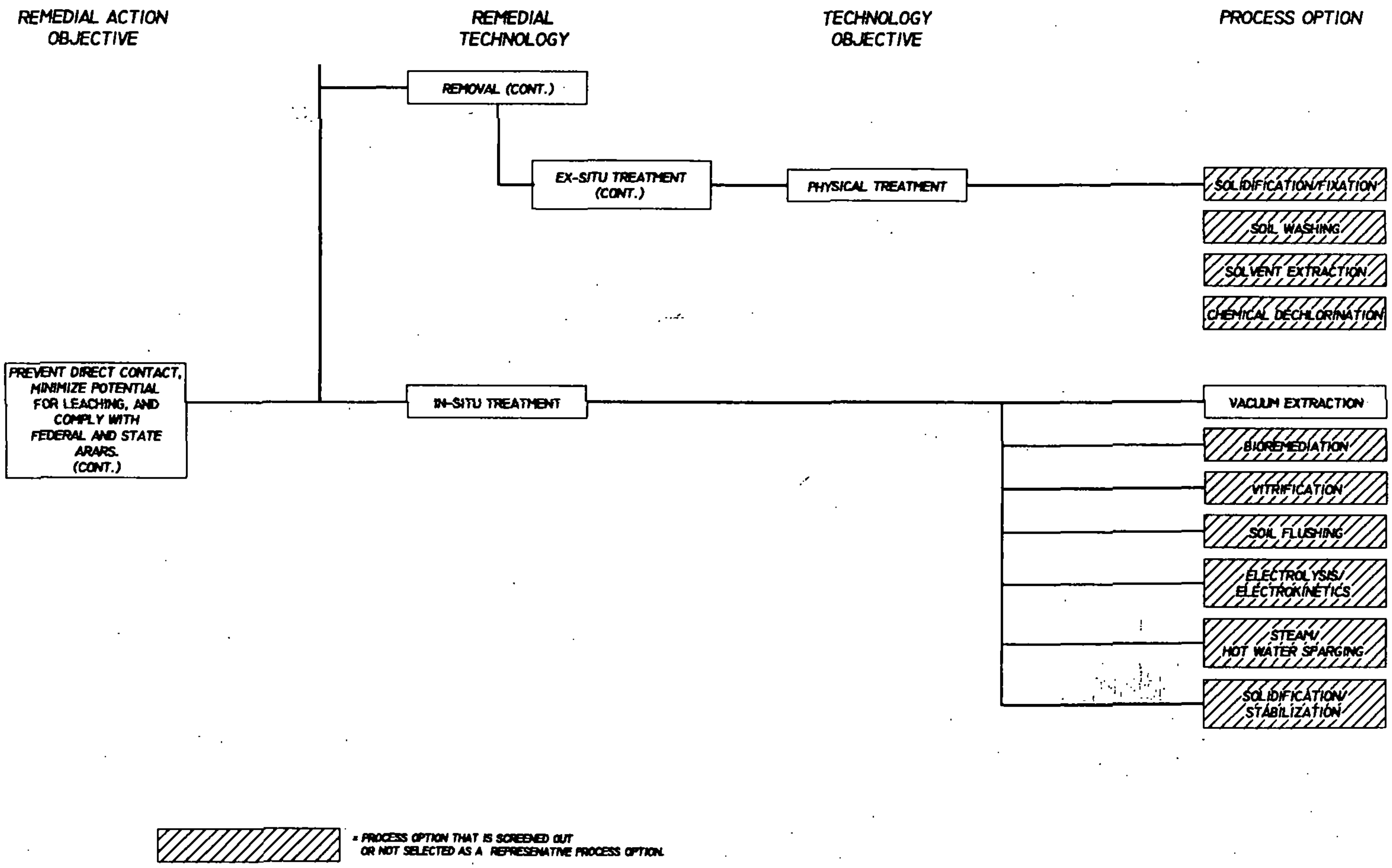
FIGURE 2-1 (CONT.)
REMEDIAL TECHNOLOGY SCREENING SUMMARY / SWDA AND IWS AREAS



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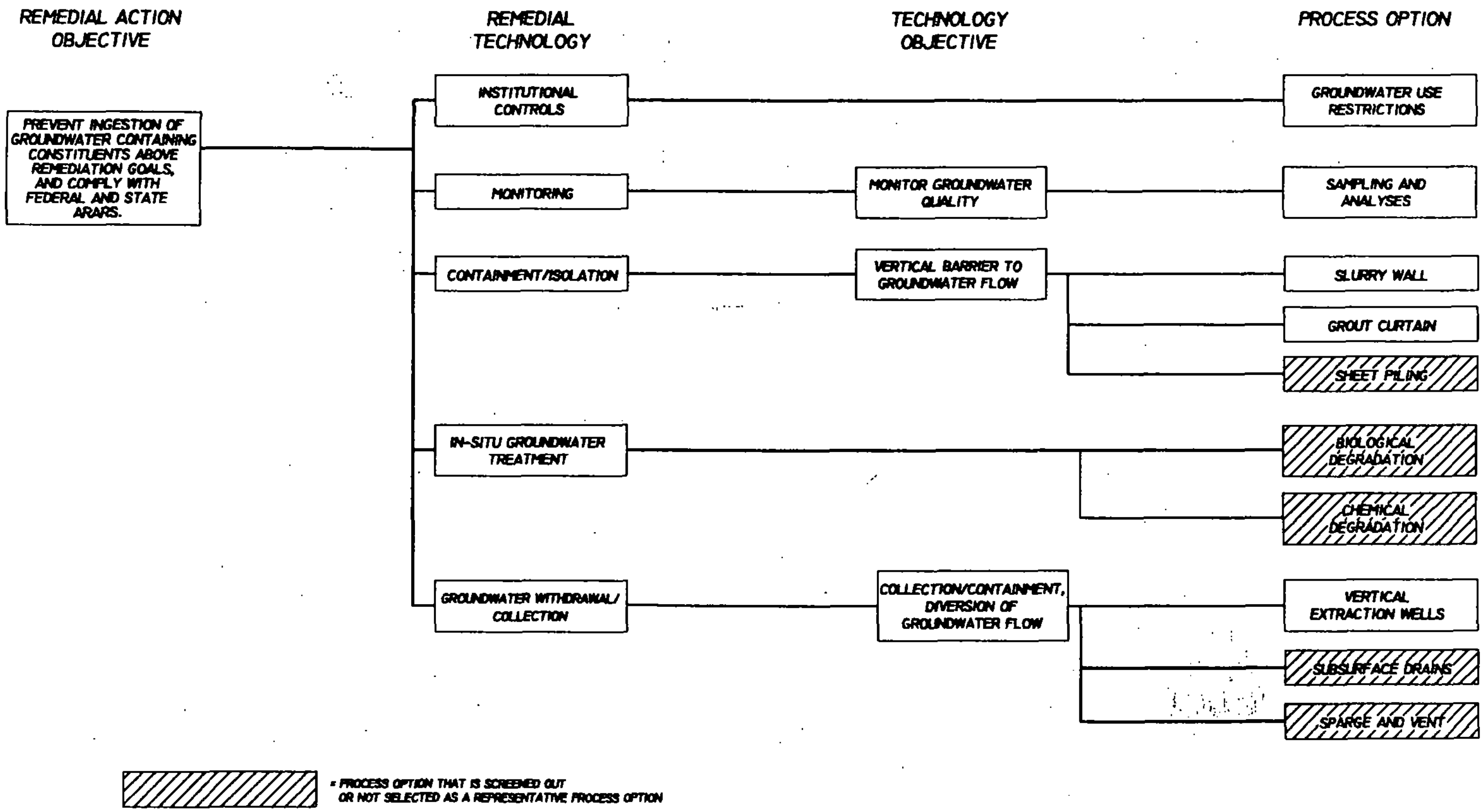
FEASIBILITY STUDY

FIGURE 2-2

REMEDIAL TECHNOLOGY SCREENING SUMMARY / GROUNDWATER



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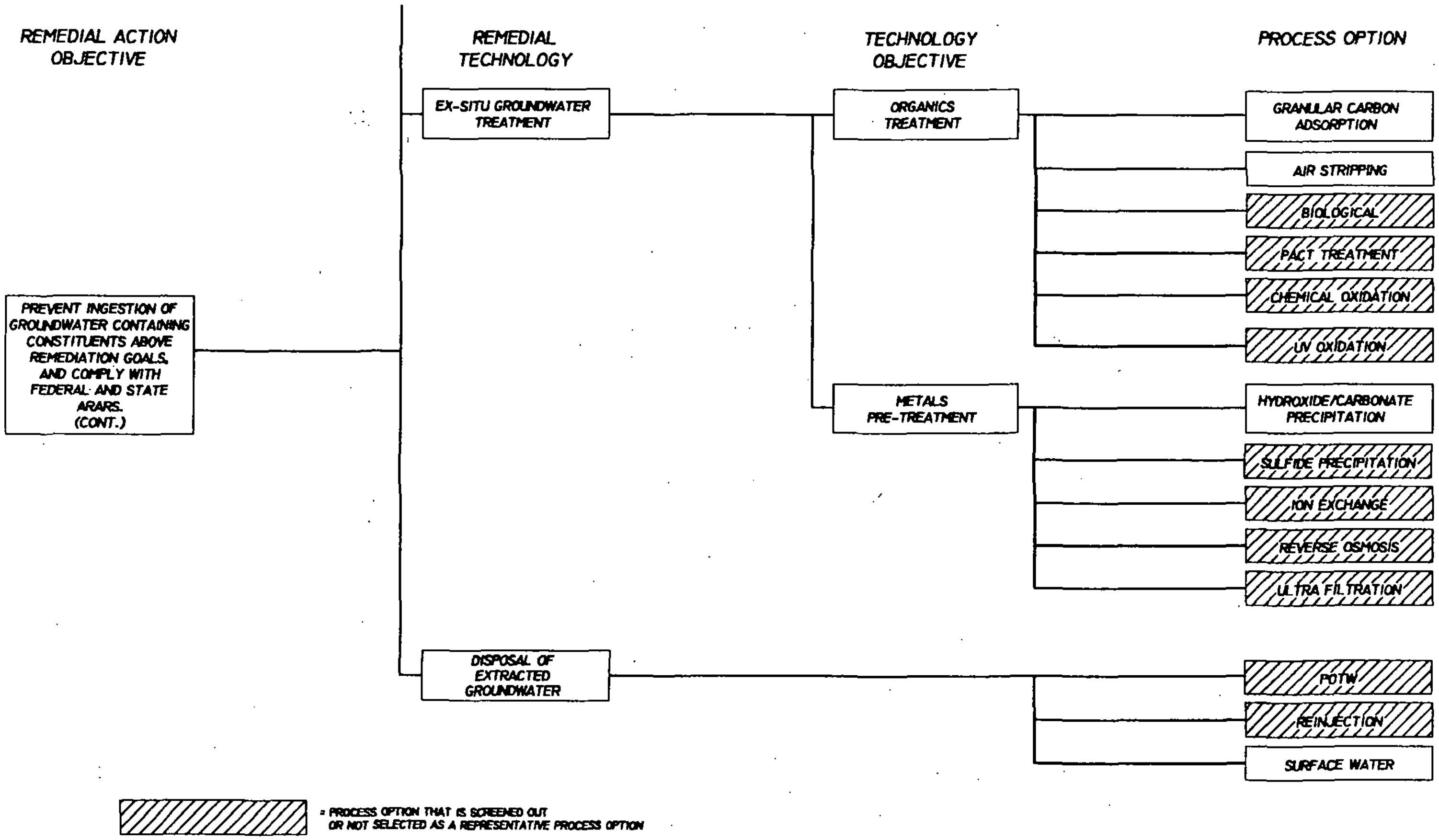
FEASIBILITY STUDY

FIGURE 2-2 (CONT.)

REMEDIAL TECHNOLOGY SCREENING SUMMARY / GROUNDWATER



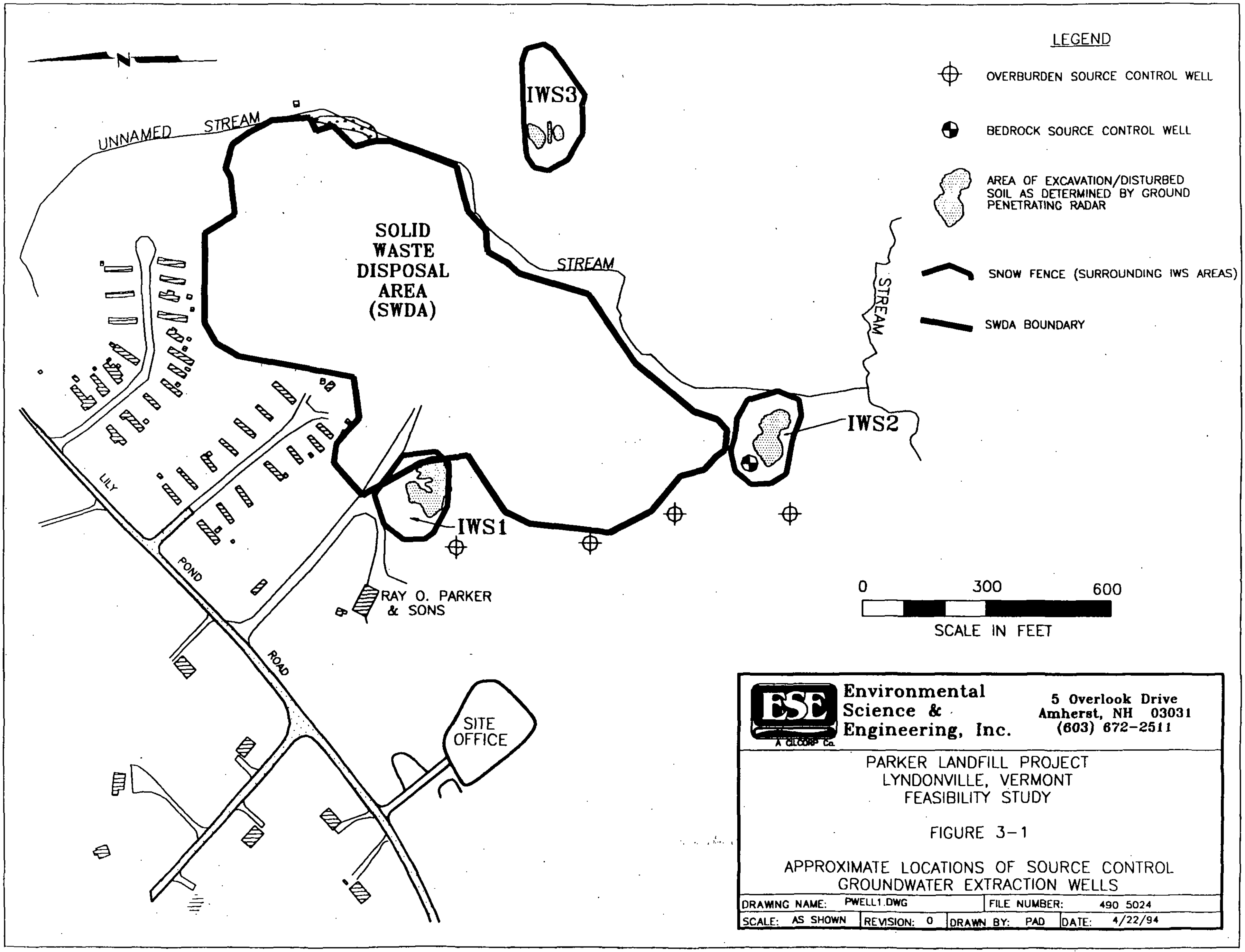

N
UNNAMED STREAM
STREAM
STREAM
IWS3
IWS2
IWS1
SOLID WASTE DISPOSAL AREA (SWDA)
LILY POND ROAD
RAY O. PARKER & SONS
SITE OFFICE
LEGEND
OVERBURDEN SOURCE CONTROL WELL
BEDROCK SOURCE CONTROL WELL
AREA OF EXCAVATION/DISTURBED SOIL AS DETERMINED BY GROUND PENETRATING RADAR
SNOW FENCE (SURROUNDING IWS AREAS)
SWDA BOUNDARY
0
300
600
SCALE IN FEET
ESE
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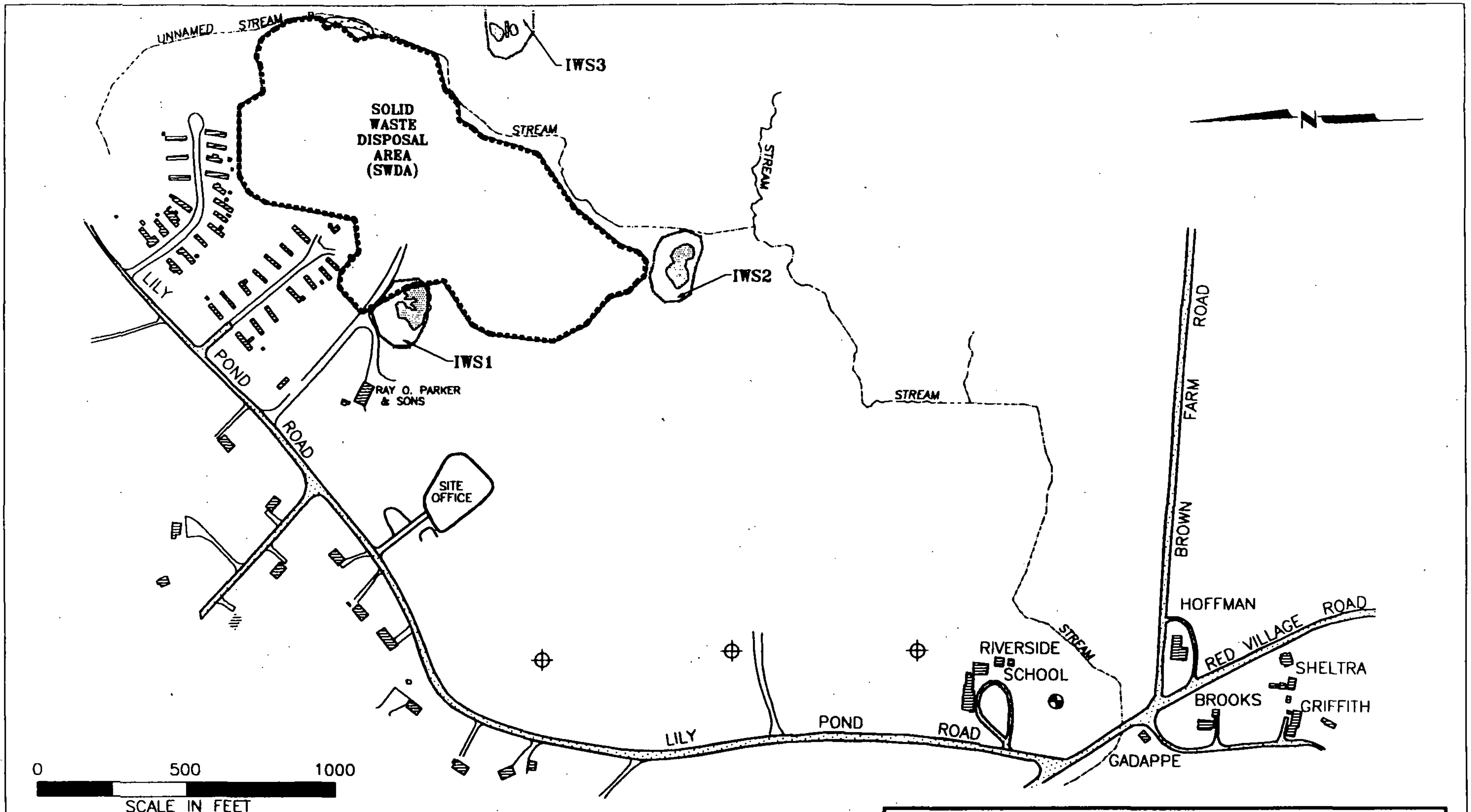
FIGURE 3-1
APPROXIMATE LOCATIONS OF SOURCE CONTROL GROUNDWATER EXTRACTION WELLS
DRAWING NAME: PWELL1.DWG
FILE NUMBER: 490 5024
SCALE: AS SHOWN
REVISION: 0
DRAWN BY: PAD
DATE: 4/22/94



LEGEND

- OVERBURDEN MANAGEMENT OF MIGRATION WELL
- BEDROCK MANAGEMENT OF MIGRATION WELL
- AREA OF EXCAVATION/DISTURBED SOIL AS DETERMINED BY GROUND PENETRATING RADAR
- SNOW FENCE (SURROUNDING IWS AREAS)
- SWDA BOUNDARY

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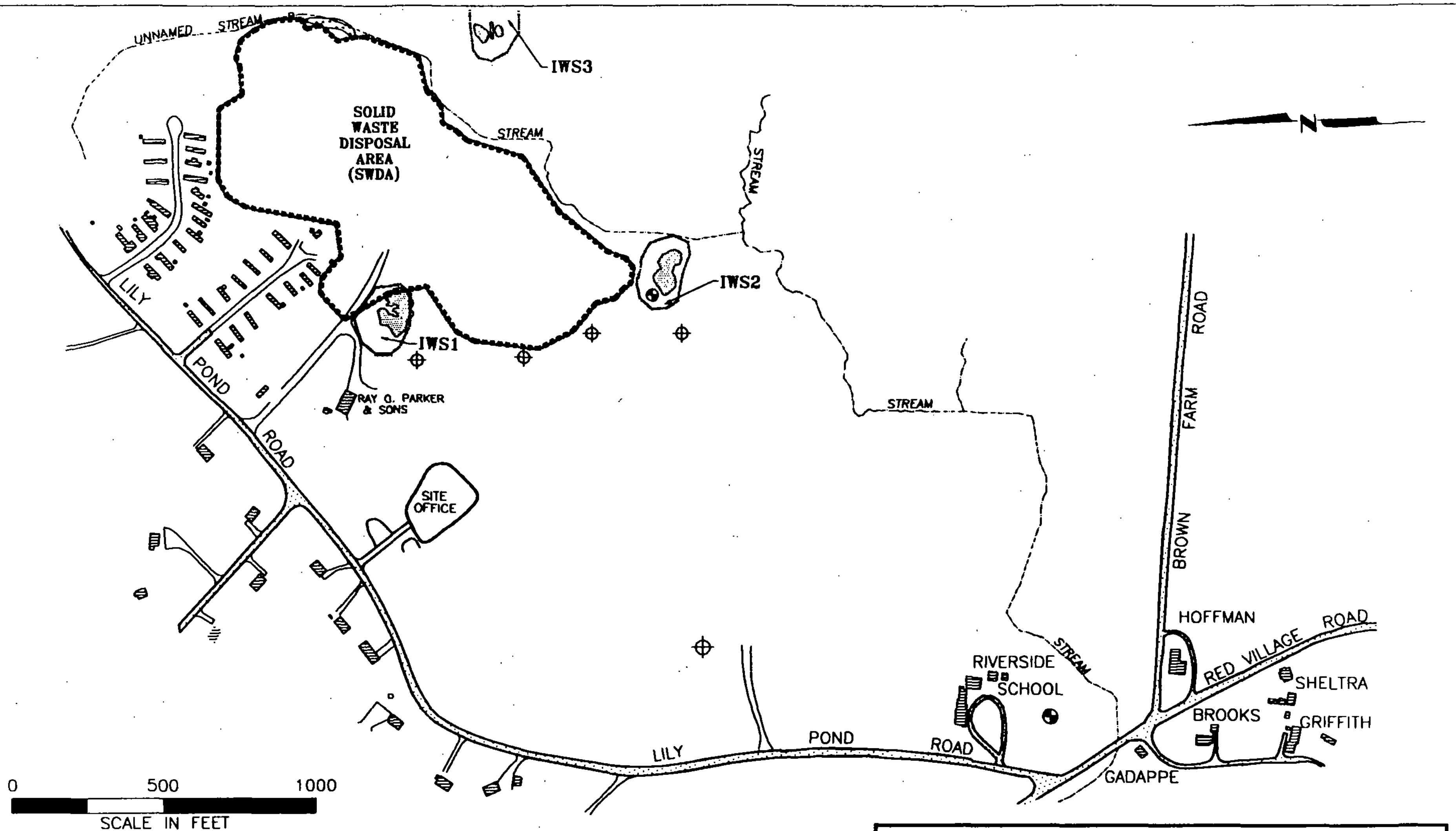
FIGURE 3-2

APPROXIMATE LOCATIONS OF MANAGEMENT OF MIGRATION GROUNDWATER EXTRACTION WELLS

DRAWING NAME: PWELL2.DWG		FILE NUMBER: 490 5024	
SCALE: AS SHOWN	REVISION: 0	DRAWN BY: PAD	DATE: 4/22/94



LEGEND

- OVERBURDEN SOURCE CONTROL AND MANAGEMENT OF MIGRATION WELL
- BEDROCK SOURCE CONTROL AND MANAGEMENT OF MIGRATION WELL
- AREA OF EXCAVATION/DISTURBED SOIL AS DETERMINED BY GROUND PENETRATING RADAR
- SNOW FENCE (SURROUNDING IWS AREAS)
- SWDA BOUNDARY

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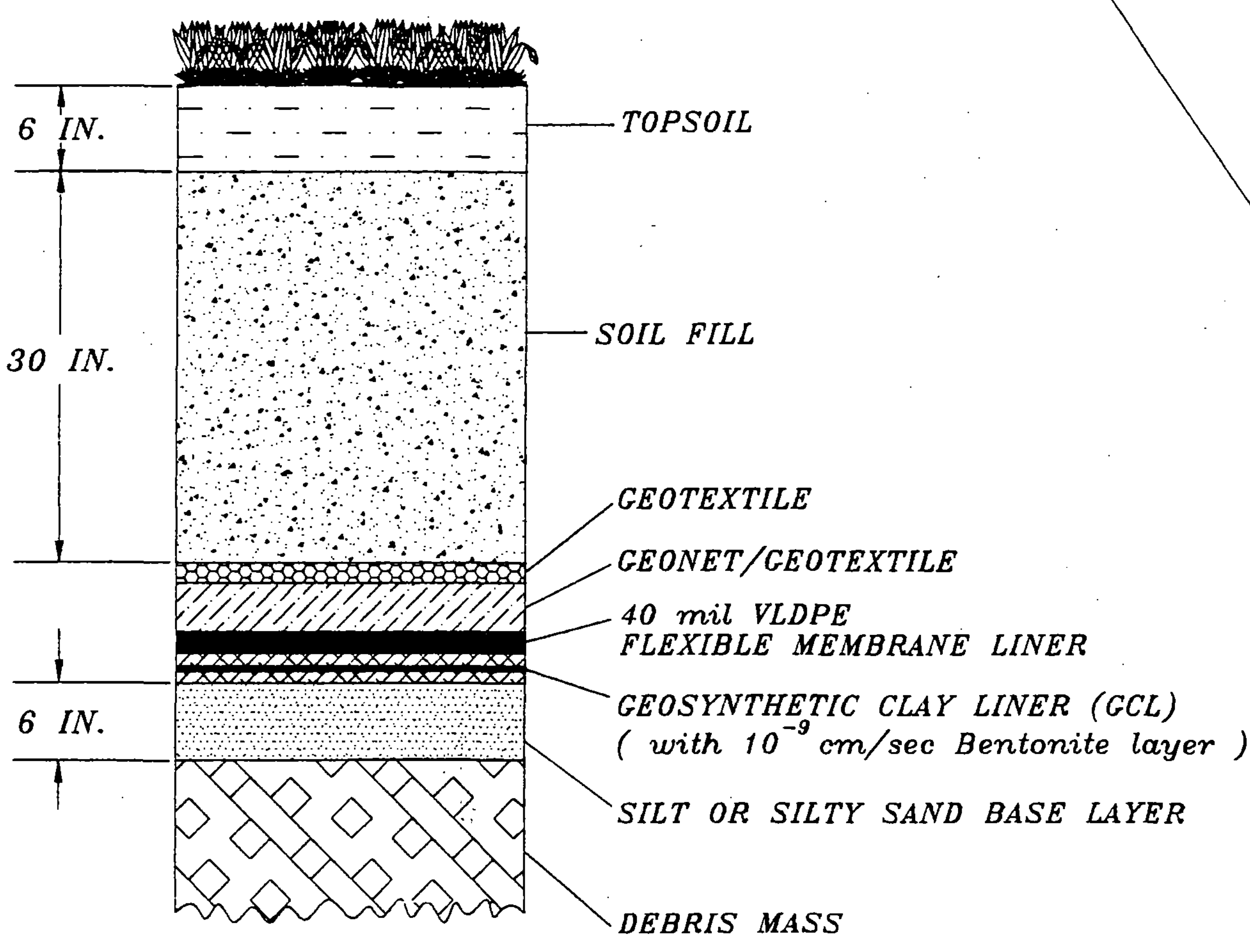
FIGURE 3-3

APPROXIMATE LOCATIONS OF SOURCE CONTROL AND MANAGEMENT OF MIGRATION GROUNDWATER EXTRACTION WELLS

DRAWING NAME: PWELL3.DWG		FILE NUMBER: 490 5024	
SCALE: AS SHOWN	REVISION: 0	DRAWN BY: PAD	DATE: 4/22/94



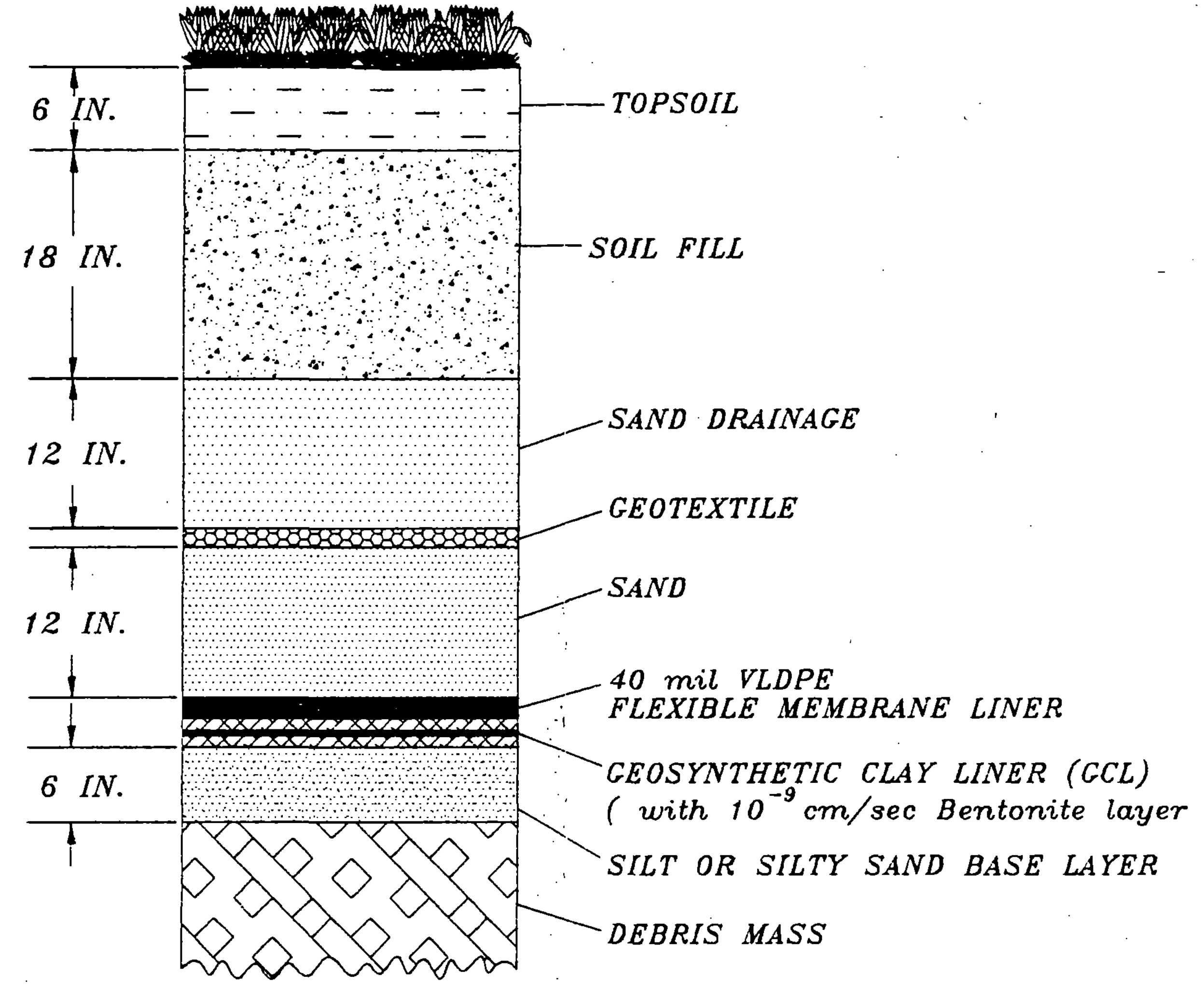


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FIGURE 4-1

RCRA CAP TOP SLOPE DESIGN

DRAWING NAME: RCCAPF.DWG		FILE NUMBER: 490 5024	
SCALE: N.T.S.	REVISION: 0	DRAWN BY: DJB	DATE: 4/22/94

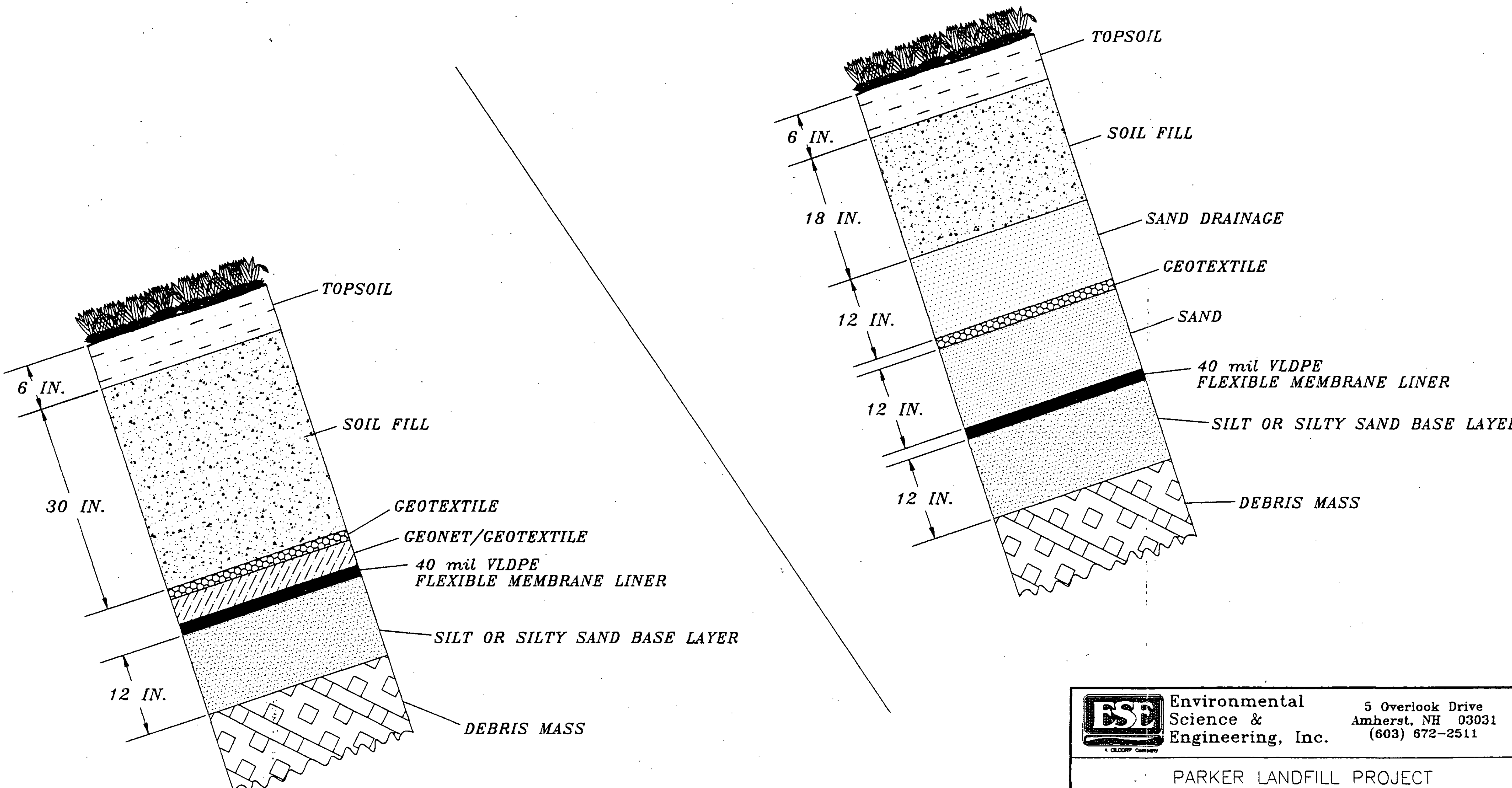

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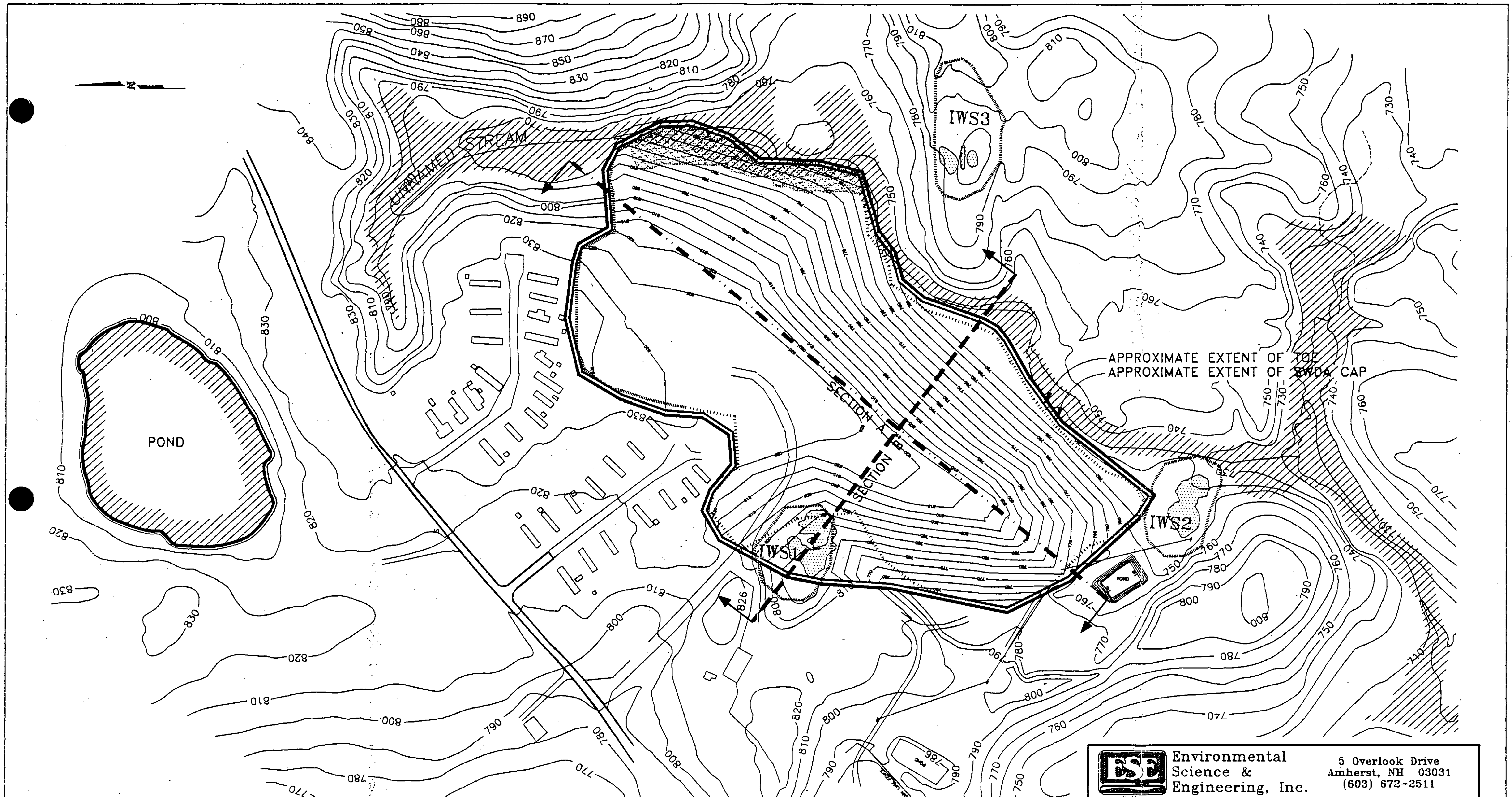
FIGURE 4-2

RCRA CAP SIDE SLOPE DESIGN

DRAWING NAME: RCCAPS.DWG		FILE NUMBER: 490 5024	
SCALE: N.T.S.	REVISION: 0	DRAWN BY: DJB	DATE: 4/22/94



LEGEND

WETLAND

APPROXIMATE LIMIT OF DEMOLITION DEBRIS AREA (DDA)

NOTE: REFER TO FIGURE 4-4 FOR CAP CROSS-SECTIONS.

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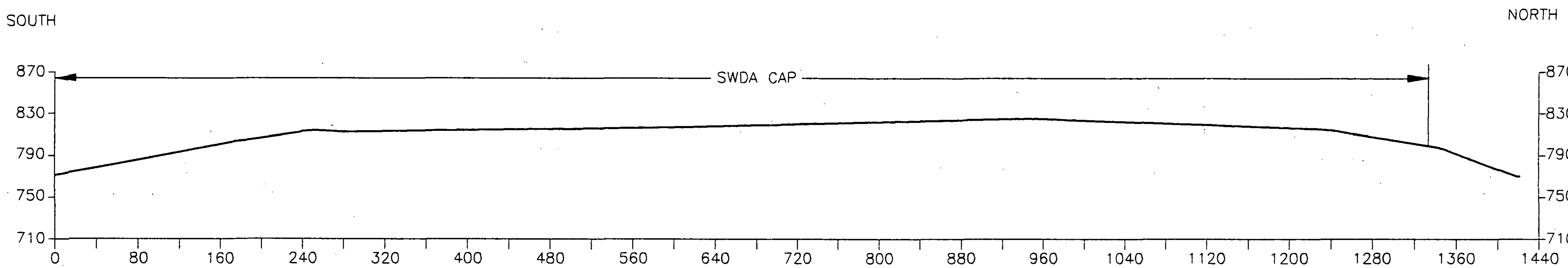
FIGURE 4-3

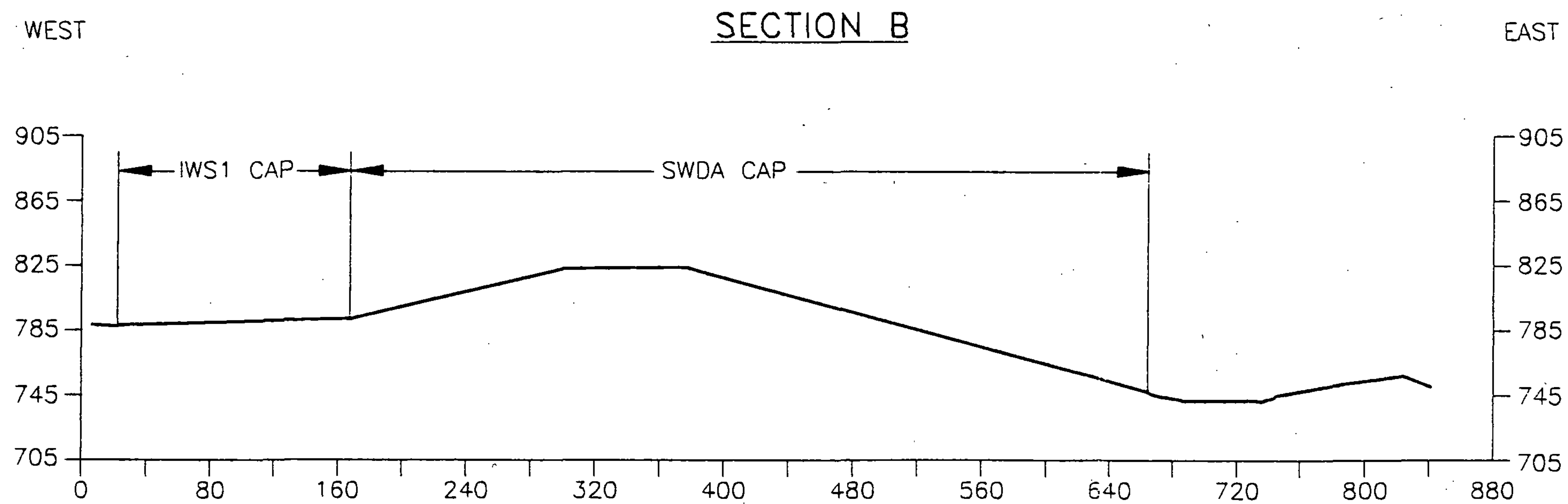
PROPOSED SWDA POST-CLOSURE
TOPOGRAPHIC PLAN

DRAWING NAME: PCTOPOB.DWG		FILE NUMBER: 490 5024	
SCALE: AS SHOWN	REVISION: 0	DRAWN BY: DJB	DATE: 4/22/94

SECTION A



SECTION B



0 50 100
SCALE FEET
HORIZONTAL
& VERTICAL

NOTE: REFER TO FIGURE 4-3 FOR LOCATION OF CROSS-SECTIONS.

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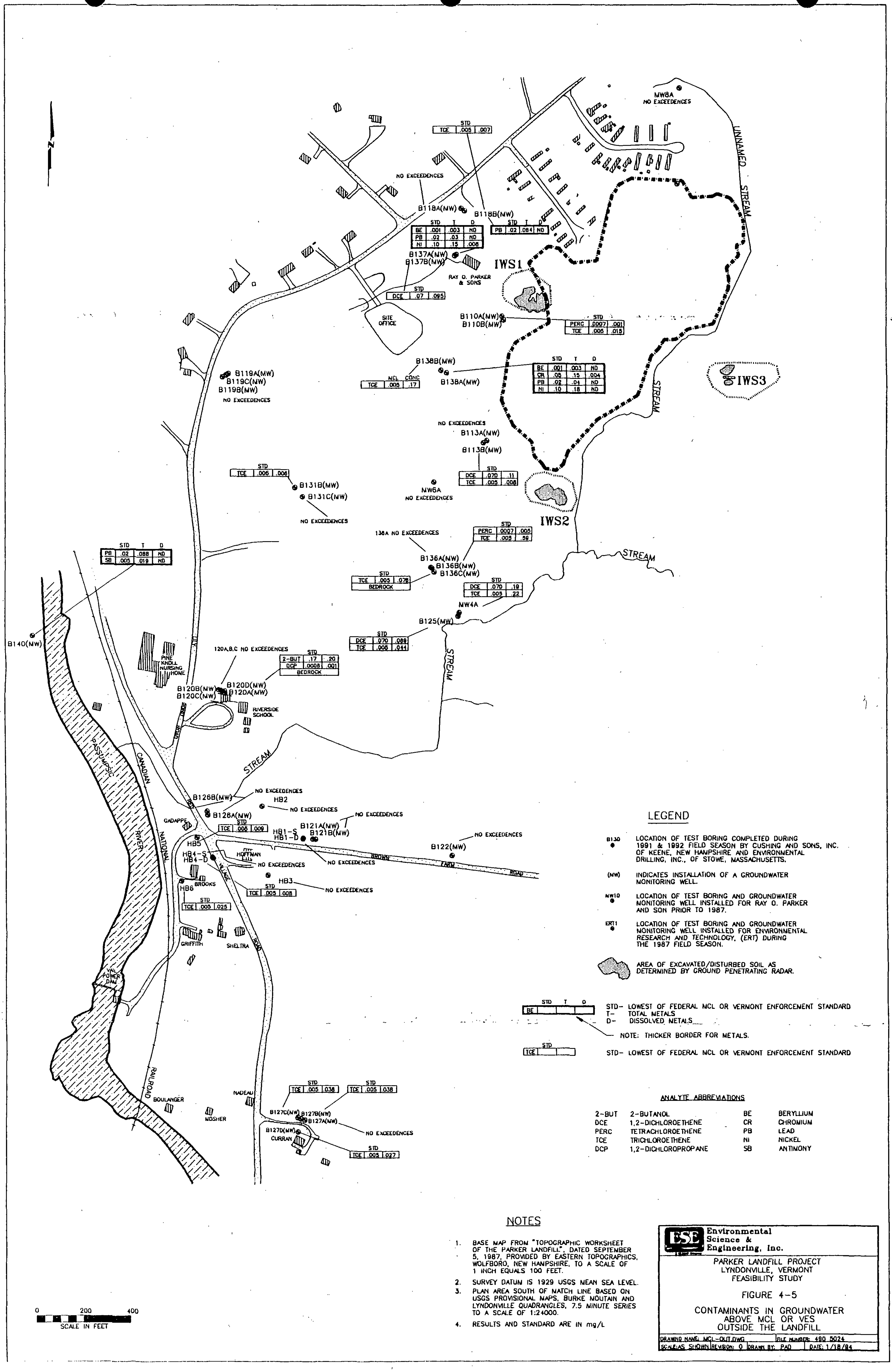
FIGURE 4-4

CROSS-SECTIONS THROUGH PROPOSED SWDA CAP

DRAWING NAME: X-CAP.DWG		FILE NUMBER: 490 5024	
SCALE: AS SHOWN	REVISION: 0	DRAWN BY: PAD	DATE: 1/18/94



MW8A
NO EXCEEDENCES
UNNAMED STREAM
STD TCE .005 .007
NO EXCEEDENCES
B118A(MW)
B118B(MW)
STD T D
BE .001 .003 ND
PB .02 .03 ND
NI .10 .15 .006
STD T D
PB .02 .084 ND
B137A(MW)
B137B(MW)
RAY O. PARKER & SONS
IWS1
STD DCE .07 .095
SITE OFFICE
B110A(MW)
B110B(MW)
STD PERC .0007 .001
TCE .005 .015
B138B(MW)
B138A(MW)
MCL CONC TCE .005 .17
STD T D
BE .001 .003 ND
CR .05 .15 .004
PB .02 .04 ND
NI .10 .18 ND
IWS3
STREAM
B119A(MW)
B119C(MW)
B119B(MW)
NO EXCEEDENCES
NO EXCEEDENCES
B113A(MW)
B113B(MW)
STD DCE .070 .11
TCE .005 .008
STD TCE .005 .006
B131B(MW)
B131C(MW)
NO EXCEEDENCES
MW6A
NO EXCEEDENCES
IWS2
136A NO EXCEEDENCES
STD PERC .0007 .005
TCE .005 .59
STREAM
STD T D
PB .02 .088 ND
SB .005 .019 ND
B136A(MW)
B136B(MW)
B136C(MW)
STD TCE .005 .076 BEDROCK
STD DCE .070 .19
TCE .005 .22
MW4A
B125(MW)
B140(MW)
STD DCE .070 .089
TCE .005 .044
120A,B,C NO EXCEEDENCES
STD 2-BUT .17 .20
DCP .0008 .001
BEDROCK
STREAM
PINE KNOLL NURSING HOME
B120B(MW)
B120C(MW)
B120D(MW)
B120A(MW)
RIVERSIDE SCHOOL
PASSUMPSIC RIVER
CANADIAN NATIONAL
STREAM
B126B(MW)
NO EXCEEDENCES
HB2
NO EXCEEDENCES
B126A(MW)
GADAPPE
STD TCE .005 .009
B121A(MW)
B121B(MW)
NO EXCEEDENCES
HB1-S
HB1-D
B122(MW)
NO EXCEEDENCES
HB5
HB4-S
HB4-D
HOFFMAN
NO EXCEEDENCES
NO EXCEEDENCES
BROWN FARM ROAD
VILLAGE ROAD
HB3
NO EXCEEDENCES
BROOKS
STD TCE .005 .008
HB6
STD TCE .005 .025
GRIFFITH
SHELTRA
VNL POWER DAM
RAILROAD
NADEAU
STD TCE .005 .038
STD TCE .005 .038
BOULANGER
MOSHER
B127C(MW)
B127B(MW)
B127A(MW)
B127D(MW)
CURRAN
NO EXCEEDENCES
STD TCE .005 .027
0 200 400
SCALE IN FEET
LEGEND
B130 LOCATION OF TEST BORING COMPLETED DURING 1991 & 1992 FIELD SEASON BY CUSHING AND SONS, INC. OF KEENE, NEW HAMPSHIRE AND ENVIRONMENTAL DRILLING, INC., OF STOWE, MASSACHUSETTS.
(MW) INDICATES INSTALLATION OF A GROUNDWATER MONITORING WELL.
MW10 LOCATION OF TEST BORING AND GROUNDWATER MONITORING WELL INSTALLED FOR RAY O. PARKER AND SON PRIOR TO 1987.
ERT1 LOCATION OF TEST BORING AND GROUNDWATER MONITORING WELL INSTALLED FOR ENVIRONMENTAL RESEARCH AND TECHNOLOGY, (ERT) DURING THE 1987 FIELD SEASON.
AREA OF EXCAVATED/DISTURBED SOIL AS DETERMINED BY GROUND PENETRATING RADAR.
STD T D BE
STD- LOWEST OF FEDERAL MCL OR VERMONT ENFORCEMENT STANDARD
T- TOTAL METALS
D- DISSOLVED METALS
NOTE: THICKER BORDER FOR METALS.
STD TCE
STD- LOWEST OF FEDERAL MCL OR VERMONT ENFORCEMENT STANDARD
ANALYTE ABBREVIATIONS
2-BUT 2-BUTANOL
DCE 1,2-DICHLOROETHENE
PERC TETRACHLOROETHENE
TCE TRICHLOROETHENE
DCP 1,2-DICHLOROPROPANE
BE BERYLLIUM
CR CHROMIUM
PB LEAD
NI NICKEL
SB ANTIMONY
NOTES
1. BASE MAP FROM "TOPOGRAPHIC WORKSHEET OF THE PARKER LANDFILL", DATED SEPTEMBER 5, 1987, PROVIDED BY EASTERN TOPOGRAPHICS, WOLFBORO, NEW HAMPSHIRE, TO A SCALE OF 1 INCH EQUALS 100 FEET.
2. SURVEY DATUM IS 1929 USGS MEAN SEA LEVEL.
3. PLAN AREA SOUTH OF MATCH LINE BASED ON USGS PROVISIONAL MAPS, BURKE MOUTAIN AND LYNDONVILLE QUADRANGLES, 7.5 MINUTE SERIES TO A SCALE OF 1:24000.
4. RESULTS AND STANDARD ARE IN mg/L
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FIGURE 4-5
CONTAMINANTS IN GROUNDWATER ABOVE MCL OR VES OUTSIDE THE LANDFILL
DRAWING NAME: MCL-OUT.DWG
FILE NUMBER: 480 5024
SCALE: AS SHOWN
REVISION: 0
DRAWN BY: PAD
DATE: 1/18/94

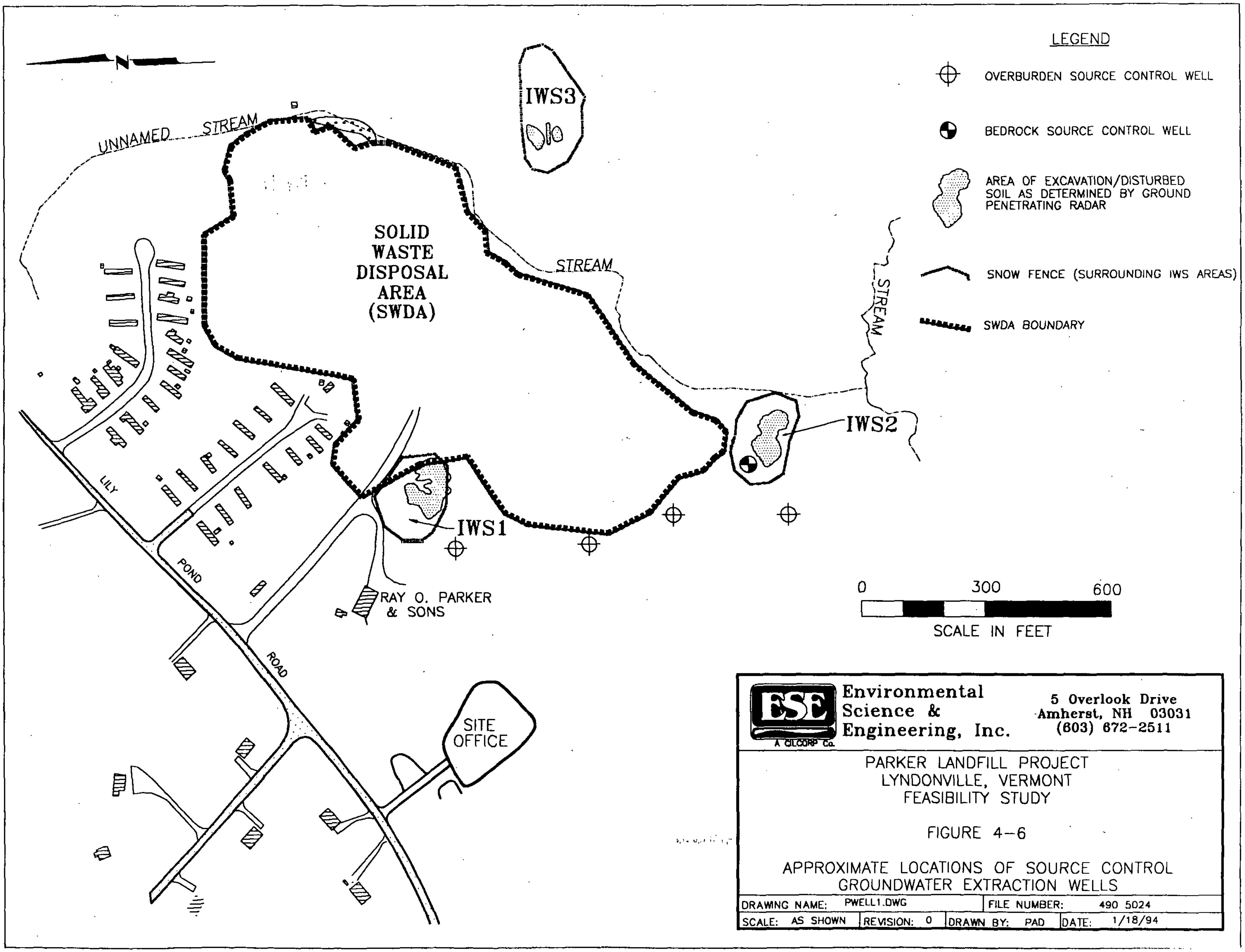
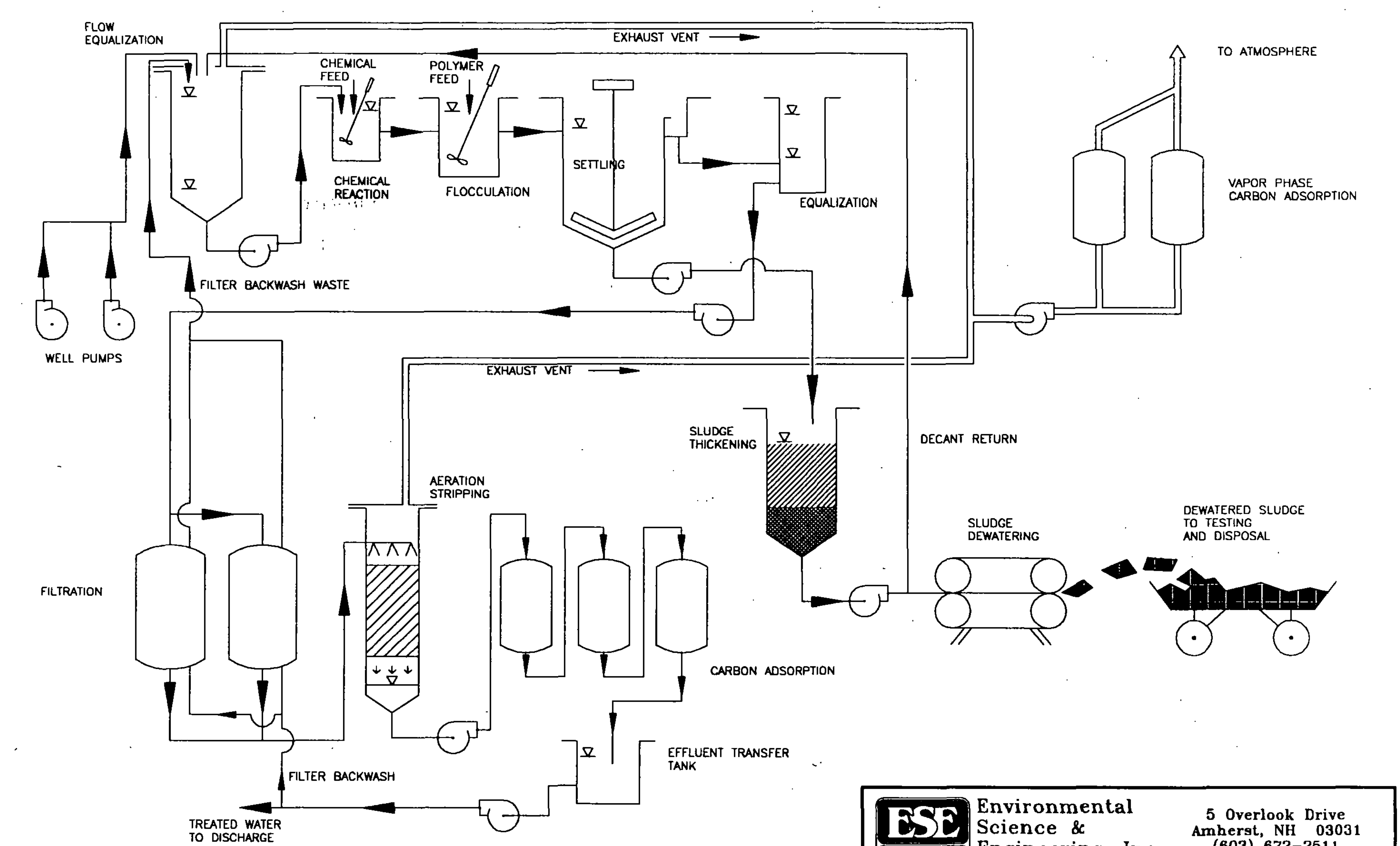


FIGURE 4-6

APPROXIMATE LOCATIONS OF SOURCE CONTROL GROUNDWATER EXTRACTION WELLS



NOTE:

THIS IS A PRELIMINARY GENERALIZED SCHEMATIC, AND DOES NOT SHOW ALL PIPING VALVES AND CONTROLS.

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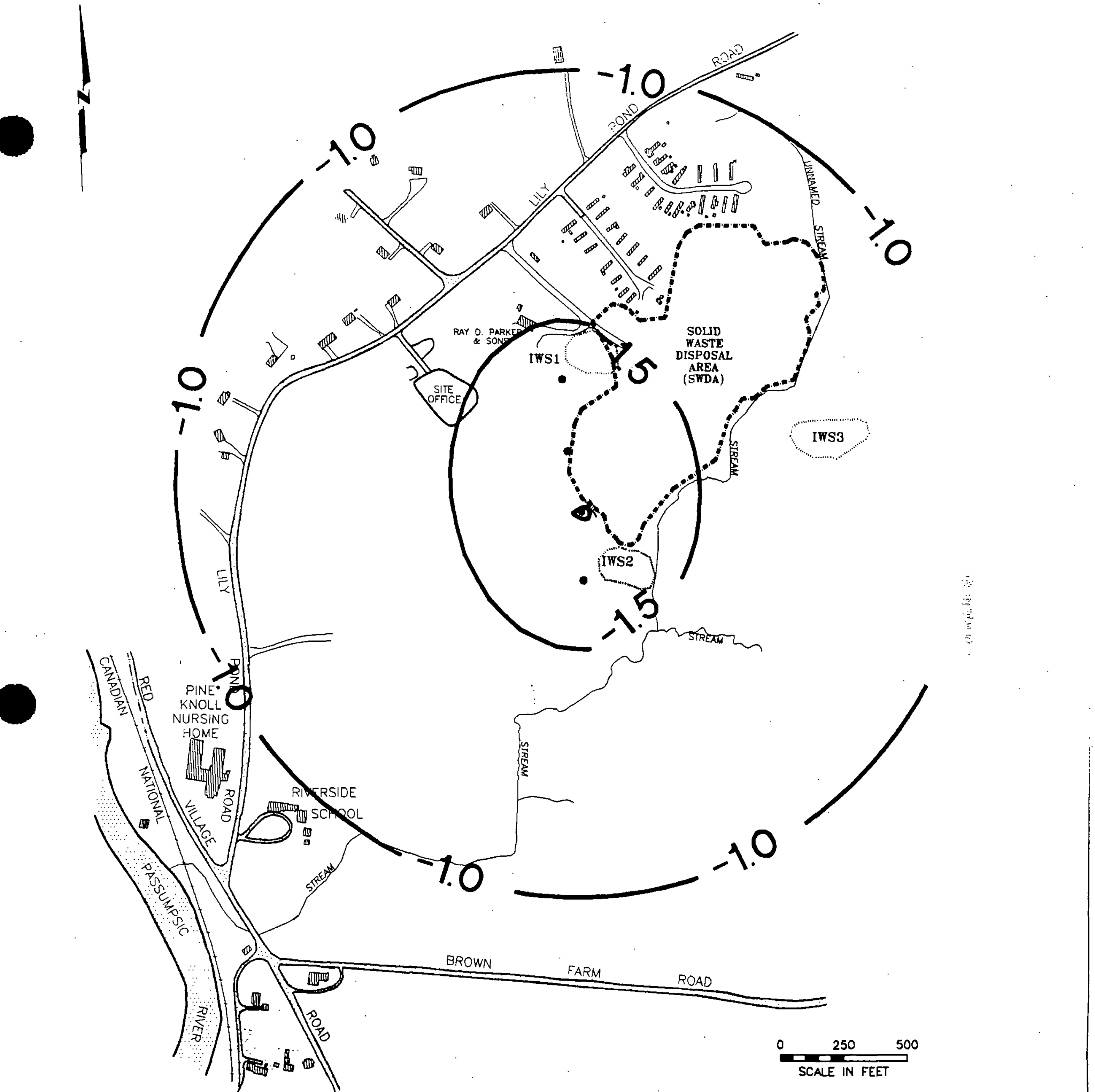
FIGURE 4-7

GROUNDWATER TREATMENT SYSTEM SCHEMATIC
METALS REDUCTION AND AIR STRIPPING
PLUS CARBON ADSORPTION

DRAWING NAME: GWTS-SCM.DWG		FILE NUMBER: 490 5024	
SCALE: N.T.S.	REVISION: 0	DRAWN BY: DJB	DATE: 4/22/94



LEGEND

• GROUNDWATER EXTRACTION WELL

— -1.0 — DRAWDOWN (IN FEET)

NOTE:

BASE MAP FROM "TOPOGRAPHIC WORKSHEET OF THE PARKER LANDFILL", DATED SEPTEMBER 5, 1987, PROVIDED BY EASTERN TOPOGRAPHICS, WOLFBORO, NEW HAMPSHIRE, TO A SCALE OF ONE INCH EQUALS 100 FEET.

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FIGURE 4-8

APPROXIMATE CONE OF INFLUENCE OF OVERBURDEN SOURCE CONTROL GROUNDWATER EXTRACTION WELLS

DRAWING NAME: DRAWDWN4.DWG		FILE NUMBER: 490 5024	
SCALE: AS SHOWN	REVISION: 0	DRAWN BY: DJB	DATE: 1/18/94

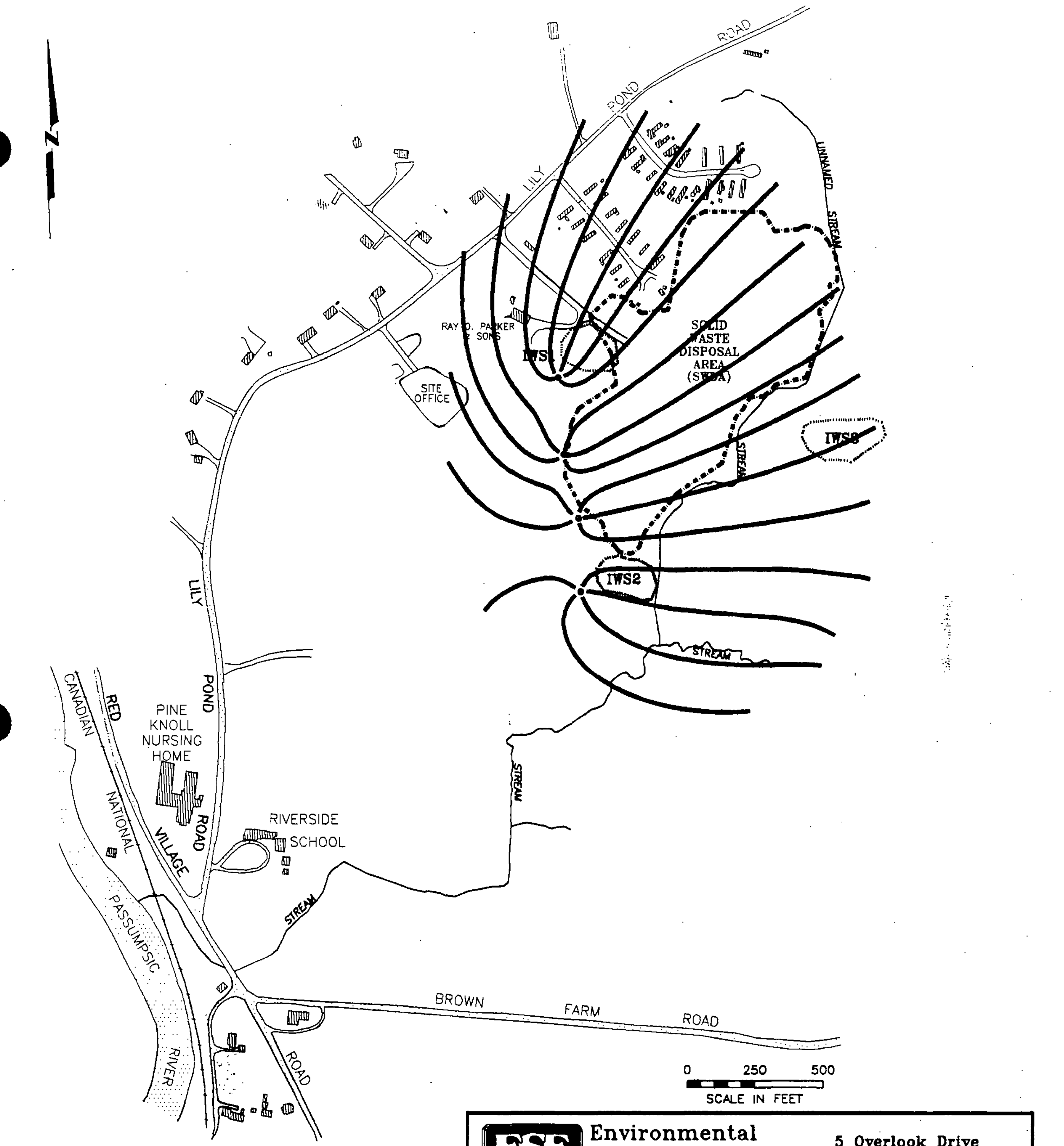

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FIGURE 4-9

APPROXIMATE CAPTURE ZONE OF SOURCE CONTROL GROUNDWATER EXTRACTION SYSTEM

DRAWING NAME: SOURCE.DWG		FILE NUMBER: 490 5024	
SCALE: AS SHOWN	REVISION: 0	DRAWN BY: DJB	DATE: 1/18/94

LEGEND

——— INDICATES APPROXIMATE CAPTURE ZONE OF PUMPING WELLS

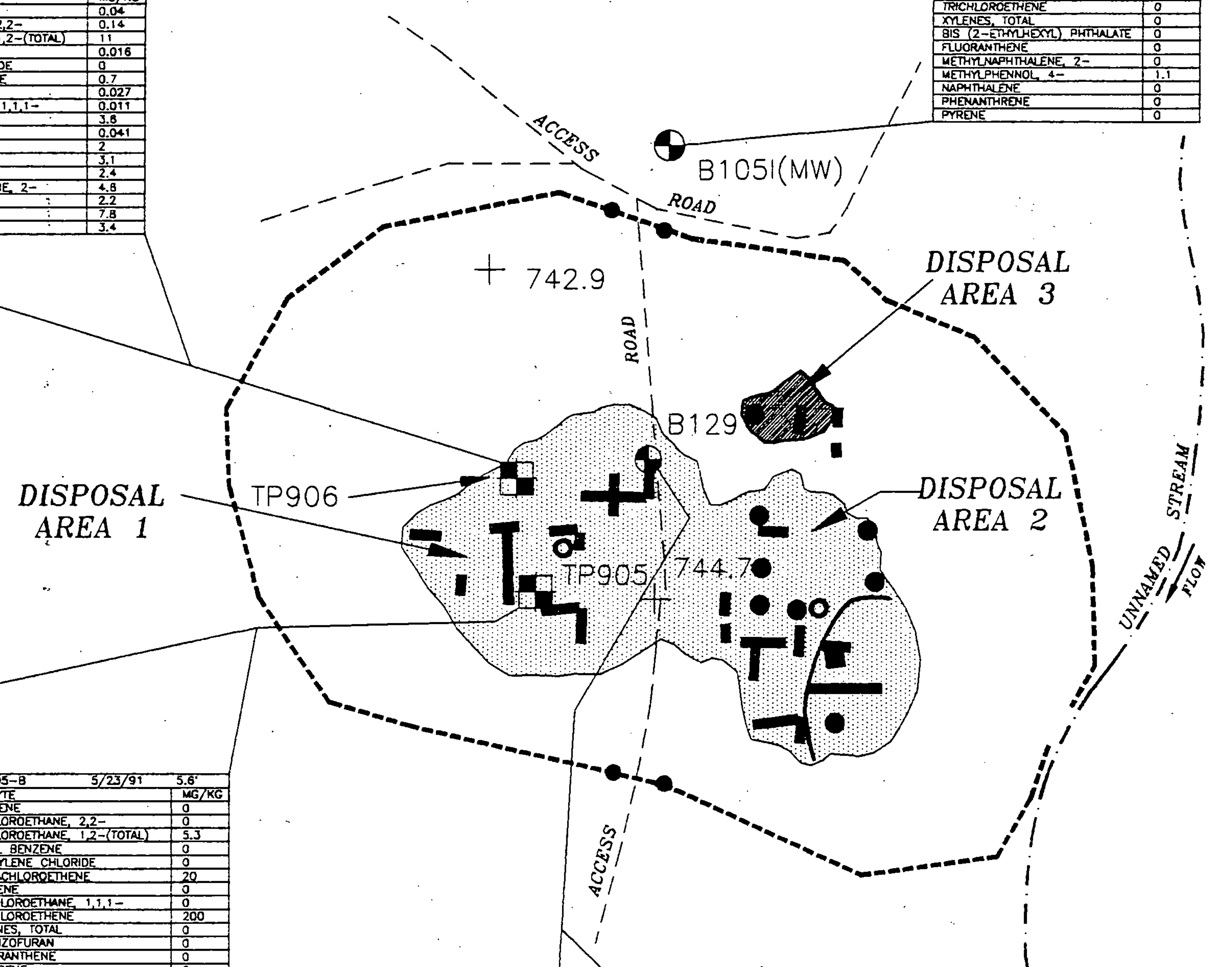
NOTE:

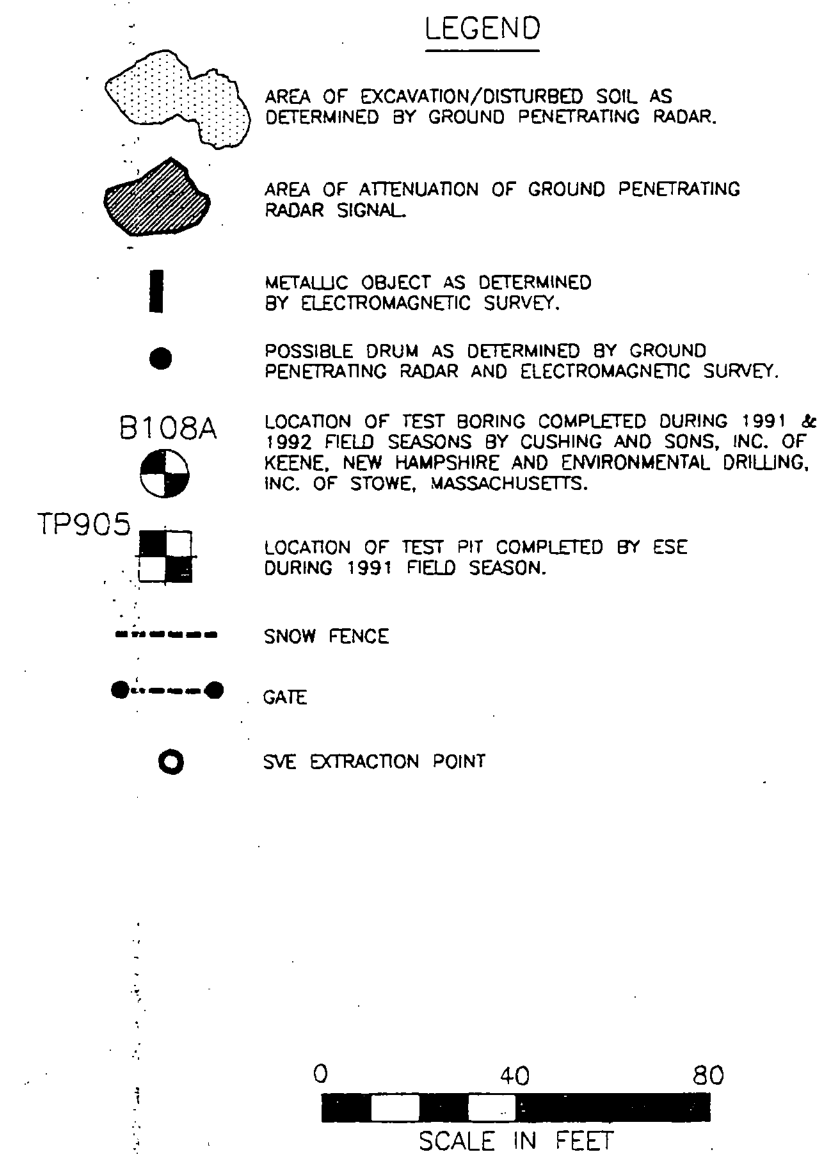
BASE MAP FROM "TOPOGRAPHIC WORKSHEET OF THE PARKER LANDFILL", DATED SEPTEMBER 5, 1987, PROVIDED BY EASTERN TOPOGRAPHICS, WOLFBORO, NEW HAMPSHIRE, TO A SCALE OF ONE INCH EQUALS 100 FEET.

P906-A	5/23/91 FILL
ANALYTE	MG/KG
BENZENE	0.04
DICHLOROETHANE, 2,2-	0.14
DICHLOROETHANE, 1,2-(TOTAL)	11
ETHYL BENZENE	0.016
METHYLENE CHLORIDE	0
TETRACHLOROETHENE	0.7
TOLUENE	0.027
TRICHLOROETHANE, 1,1,1-	0.011
TRICHLOROETHENE	3.8
XYLENES, TOTAL	0.041
DIBENZOFURAN	2
FLUORANTHENE	3.1
FLUORENE	2.4
METHYLNAPHTHALENE, 2-	4.8
NAPHTHALENE	2.2
PHENANTHRENE	7.8
PYRENE	3.4

B105-A(MW) 7/8/91	8-10'
ANALYTE	MG/KG
2-BUTANONE	0.2
ACETONE	0
CHLOROFORM	0
DICHLOROETHANE, 1,1-	0
DICHLOROETHENE, 1,2-(TOTAL)	0
ETHYL BENZENE	0
HEXANONE, 2-	0.035
METHYL, 4-2-PENTANONE	0
METHYLENE CHLORIDE	0
TETRACHLOROETHENE	0
TOLUENE	0
TRICHLOROETHENE	0
XYLENES, TOTAL	0
BIS (2-ETHYLHEXYL) PHTHALATE	0
FLUORANTHENE	0
METHYLNAPHTHALENE, 2-	0
METHYLPHENNOL, 4-	1.1
NAPHTHALENE	0
PHENANTHRENE	0
PYRENE	0

P906-B 5/23/91	9'
ANALYTE	MG/KG
BENZENE	0
DICHLOROETHANE, 2,2-	0
DICHLOROETHANE, 1,2-(TOTAL)	34
ETHYL BENZENE	0
METHYLENE CHLORIDE	6.3
TETRACHLOROETHENE	100
TOLUENE	0
TRICHLOROETHANE, 1,1,1-	1.7
TRICHLOROETHENE	2500
XYLENES, TOTAL	5.3
DIBENZOFURAN	0
FLUORANTHENE	0
FLUORENE	0
METHYLNAPHTHALENE, 2-	1.3
NAPHTHALENE	0.51
PHENANTHRENE	0
PYRENE	0





P905-A 5/23/91	FILL
ANALYTE	MG/KG
BENZENE	0
DICHLOROETHANE, 2,2-	0
DICHLOROETHANE, 1,2-(TOTAL)	540
ETHYL BENZENE	0
METHYLENE CHLORIDE	9.3
TETRACHLOROETHENE	32
TOLUENE	0
TRICHLOROETHANE, 1,1,1-	0
TRICHLOROETHENE	65
XYLENES, TOTAL	0
DIBENZOFURAN	1.7
FLUORANTHENE	0
FLUORENE	2.2
METHYLNAPHTHALENE, 2-	15
NAPHTHALENE	8.9
PHENANTHRENE	6.3
PYRENE	1.7

P905-B 5/23/91	5.6'
ANALYTE	MG/KG
BENZENE	0
DICHLOROETHANE, 2,2-	0
DICHLOROETHANE, 1,2-(TOTAL)	5.3
ETHYL BENZENE	0
METHYLENE CHLORIDE	0
TETRACHLOROETHENE	20
TOLUENE	0
TRICHLOROETHANE, 1,1,1-	0
TRICHLOROETHENE	200
XYLENES, TOTAL	0
DIBENZOFURAN	0
FLUORANTHENE	0
FLUORENE	0
METHYLNAPHTHALENE, 2-	2.4
NAPHTHALENE	0.88
PHENANTHRENE	0.86
PYRENE	0

B129-A 6/24/91	0-2'
ANALYTE	MG/KG
2-BUTANONE	0
ACETONE	25
CHLOROFORM	0
DICHLOROETHANE, 1,1-	0
DICHLOROETHENE, 1,2-(TOTAL)	72
ETHYL BENZENE	0
HEXANONE, 2-	0
METHYL, 4-2-PENTANONE	0
METHYLENE CHLORIDE	19
TETRACHLOROETHENE	93
TOLUENE	0
TRICHLOROETHENE	1000
XYLENES, TOTAL	0
BIS (2-ETHYLHEXYL) PHTHALATE	0
FLUORANTHENE	0.15
METHYLNAPHTHALENE, 2-	0.27
METHYLPHENNOL, 4-	0
NAPHTHALENE	0.11
PHENANTHRENE	0.34
PYRENE	0.16

B129-B 6/24/91	6-8'
ANALYTE	MG/KG
2-BUTANONE	0
ACETONE	0
CHLOROFORM	0
DICHLOROETHANE, 1,1-	0
DICHLOROETHENE, 1,2-(TOTAL)	0
ETHYL BENZENE	0
HEXANONE, 2-	0
METHYL, 4-2-PENTANONE	0
METHYLENE CHLORIDE	0
TETRACHLOROETHENE	13
TOLUENE	0
TRICHLOROETHENE	25
XYLENES, TOTAL	0
BIS (2-ETHYLHEXYL) PHTHALATE	0
FLUORANTHENE	0
METHYLNAPHTHALENE, 2-	0
METHYLPHENNOL, 4-	0
NAPHTHALENE	0
PHENANTHRENE	0
PYRENE	0

NOTES:

1. LOCATION OF SNOW FENCE IS APPROXIMATE.
2. WORKSHEET OF THE PARKER LANDFILL", DATED SEPTEMBER 5, 1987, BY EASTERN TOPOGRAPHICS, WOLFEBORO, NEW HAMPSHIRE, TO A SCALE OF ONE INCH EQUALS 100 FEET.

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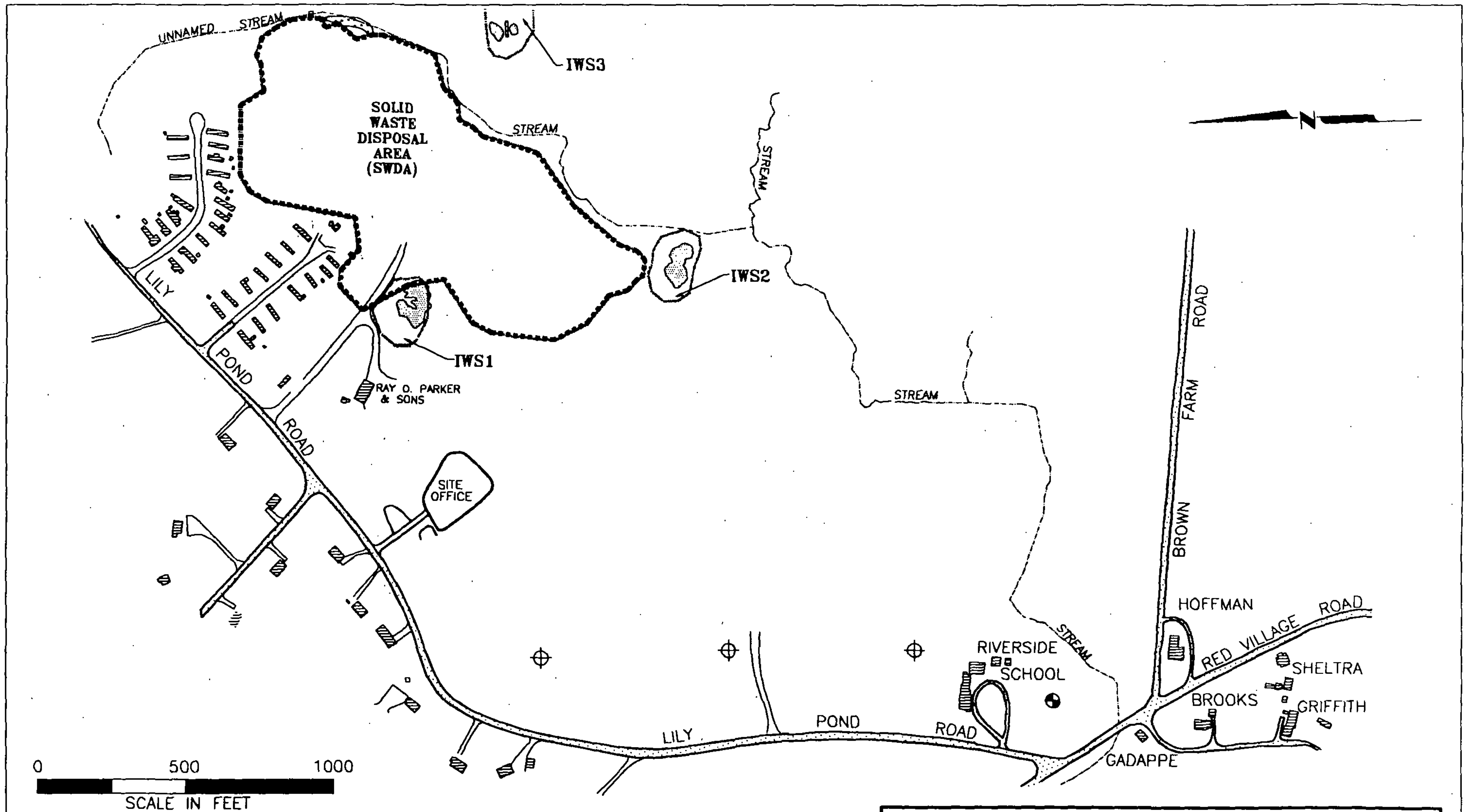
SOIL VAPOR EXTRACTIONPOINT LOCATION

(IWS2)

FIGURE 4-10

DRAWING NAME: TESTLOC2		FILE NUMBER: 490 5024	
SCALE: 1" = 40'	REVISION: 0	DRAWN BY: DJB	DATE: 4/22/94



LEGEND

- OVERBURDEN MANAGEMENT OF MIGRATION WELL
- BEDROCK MANAGEMENT OF MIGRATION WELL
- AREA OF EXCAVATION/DISTURBED SOIL AS DETERMINED BY GROUND PENETRATING RADAR
- SNOW FENCE (SURROUNDING IWS AREAS)
- SWDA BOUNDARY

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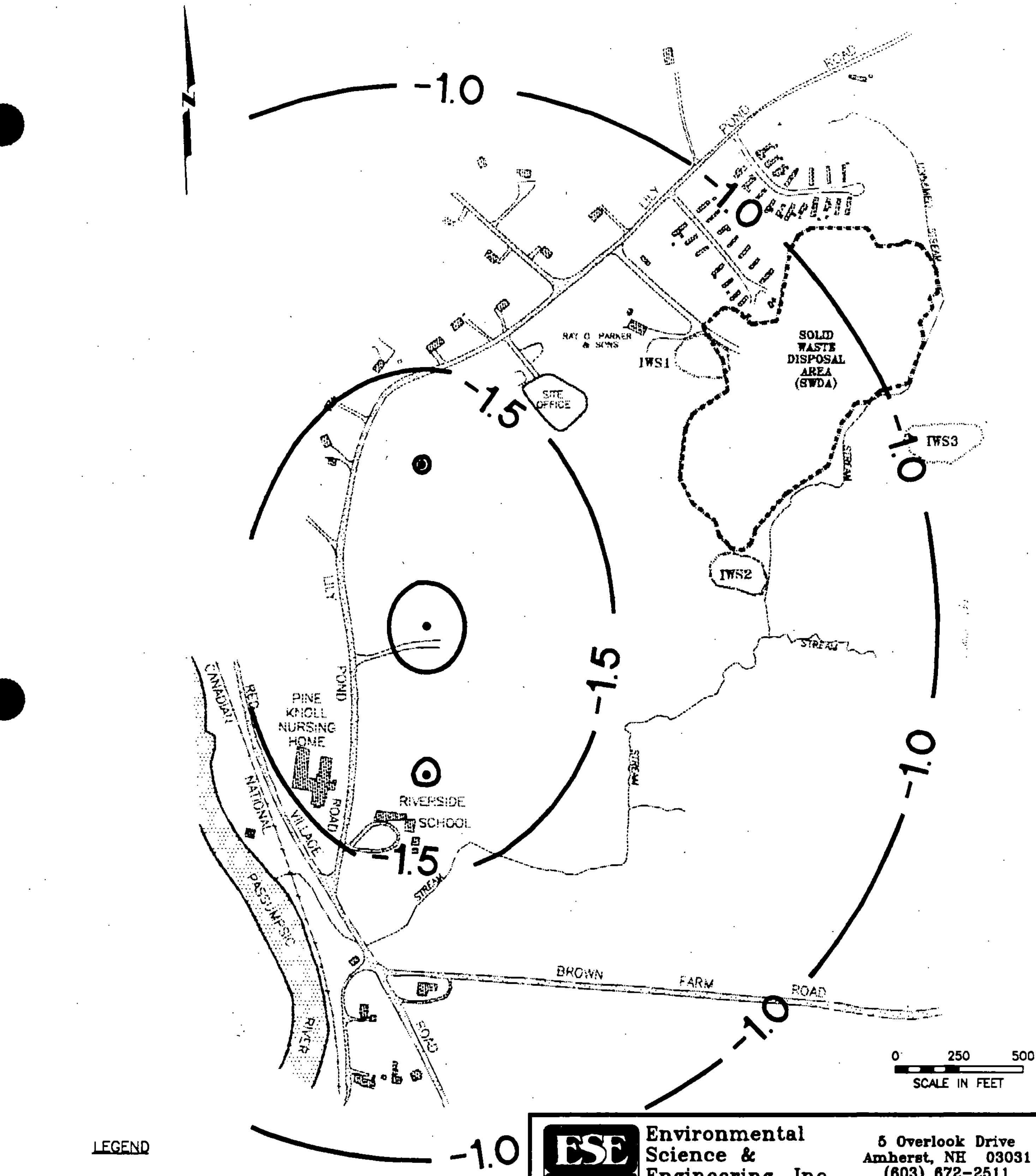
FIGURE 4-11

APPROXIMATE LOCATIONS OF MANAGEMENT OF MIGRATION GROUNDWATER EXTRACTION WELLS

DRAWING NAME: PWELL2.DWG		FILE NUMBER: 490 5024	
SCALE: AS SHOWN	REVISION: 0	DRAWN BY: PAD	DATE: 1/18/94



LEGEND

• GROUNDWATER EXTRACTION WELL

— -1.0 — DRAWDOWN (IN FEET)

NOTE:

BASE MAP FROM "TOPOGRAPHIC WORKSHEET OF THE PARKER LANDFILL", DATED SEPTEMBER 5, 1987, PROVIDED BY EASTERN TOPOGRAPHICS, WOLFBORO, NEW HAMPSHIRE, TO A SCALE OF ONE INCH EQUALS 100 FEET.

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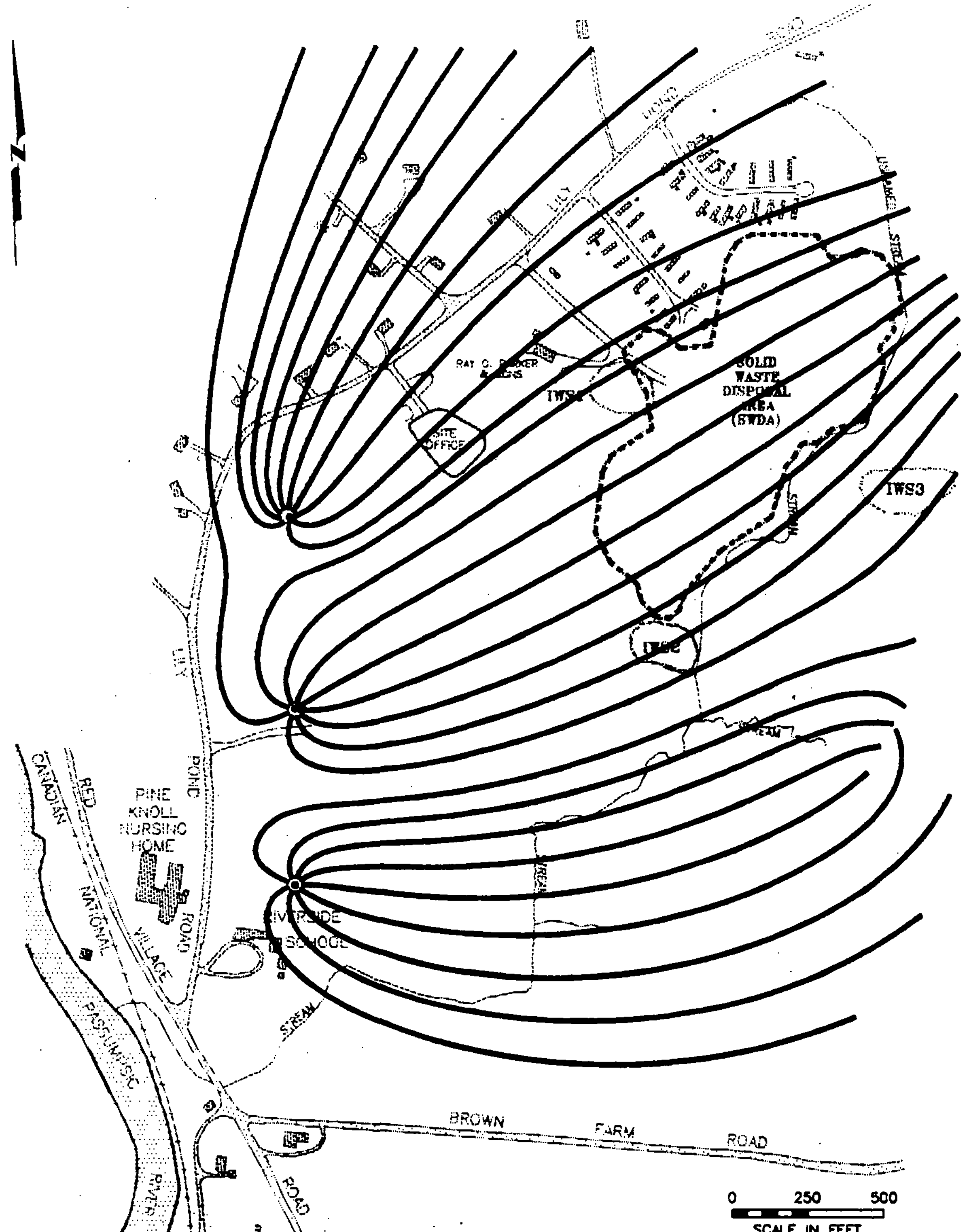
FIGURE 4-12

APPROXIMATE CONE OF INFLUENCE OF OVERBURDEN MANAGEMENT OF MIGRATION GROUNDWATER EXTRACTION WELLS

DRAWING NAME: DRAWDWN3.DWG		FILE NUMBER: 490 5024	
SCALE: AS SHOWN	REVISION: 0	DRAWN BY: PAD	DATE: 1/18/94



LEGEND

INDICATES APPROXIMATE CAPTURE ZONE OF PUMPING WELLS

NOTE:
BASE MAP FROM "TOPOGRAPHIC WORKSHEET OF THE PARKER LANDFILL", DATED SEPTEMBER 5, 1987, PROVIDED BY EASTERN TOPOGRAPHICS, WOLFBORO, NEW HAMPSHIRE, TO A SCALE OF ONE INCH EQUALS 100 FEET.

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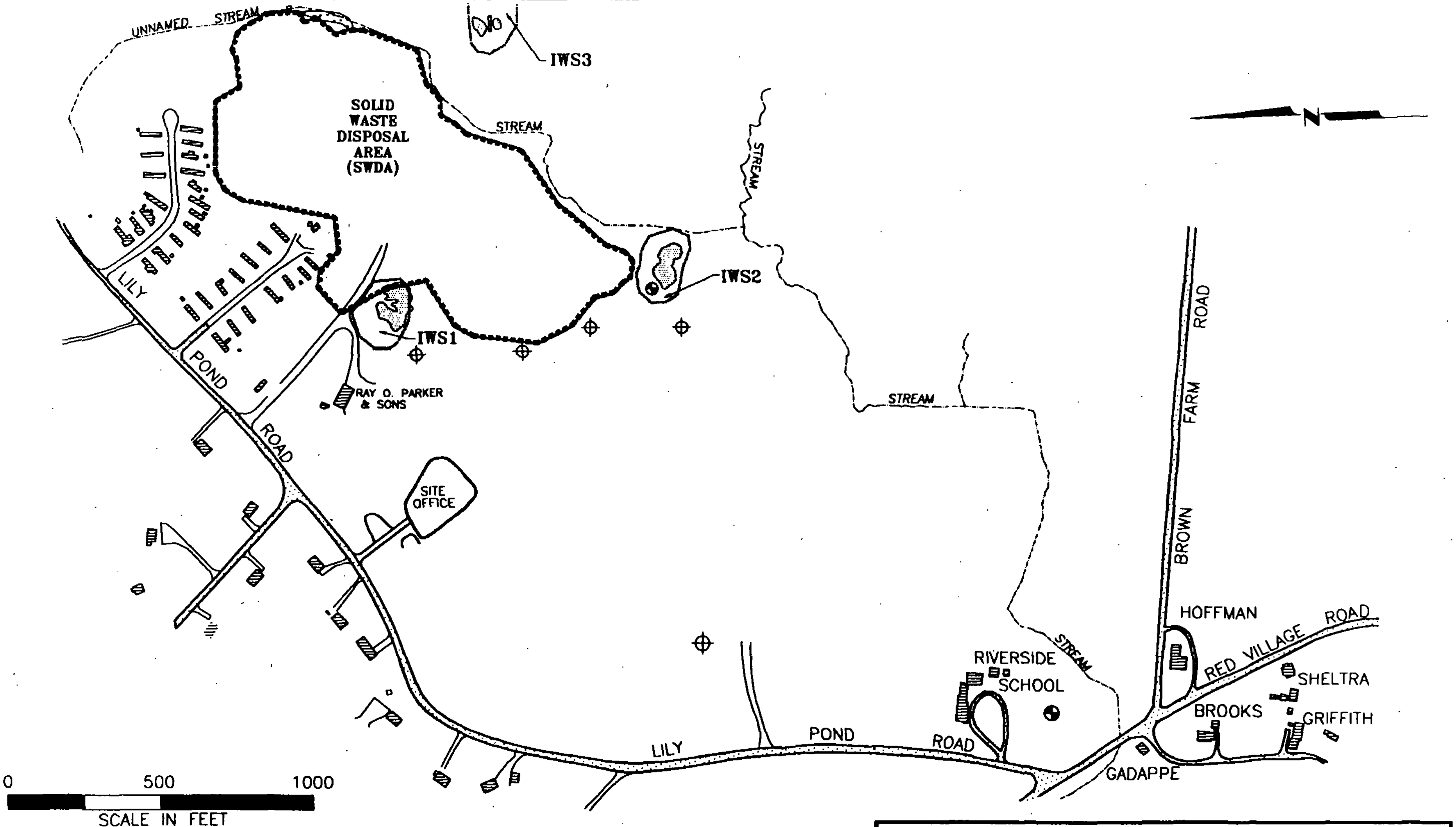
FIGURE 4-13

APPROXIMATE CAPTURE ZONE OF OVERBURDEN MANAGEMENT OF MIGRATION EXTRACTION SYSTEM

DRAWING NAME: NOSOURCE.DWG		FILE NUMBER: 490 5024	
SCALE: AS SHOWN	REVISION: 0	DRAWN BY: DJB	DATE: 1/18/94



LEGEND

⊕ OVERBURDEN SOURCE CONTROL AND MANAGEMENT OF MIGRATION WELL

BEDROCK SOURCE CONTROL AND MANAGEMENT OF MIGRATION WELL

AREA OF EXCAVATION/DISTURBED SOIL AS DETERMINED BY GROUND PENETRATING RADAR

SNOW FENCE (SURROUNDING IWS AREAS)

SWDA BOUNDARY

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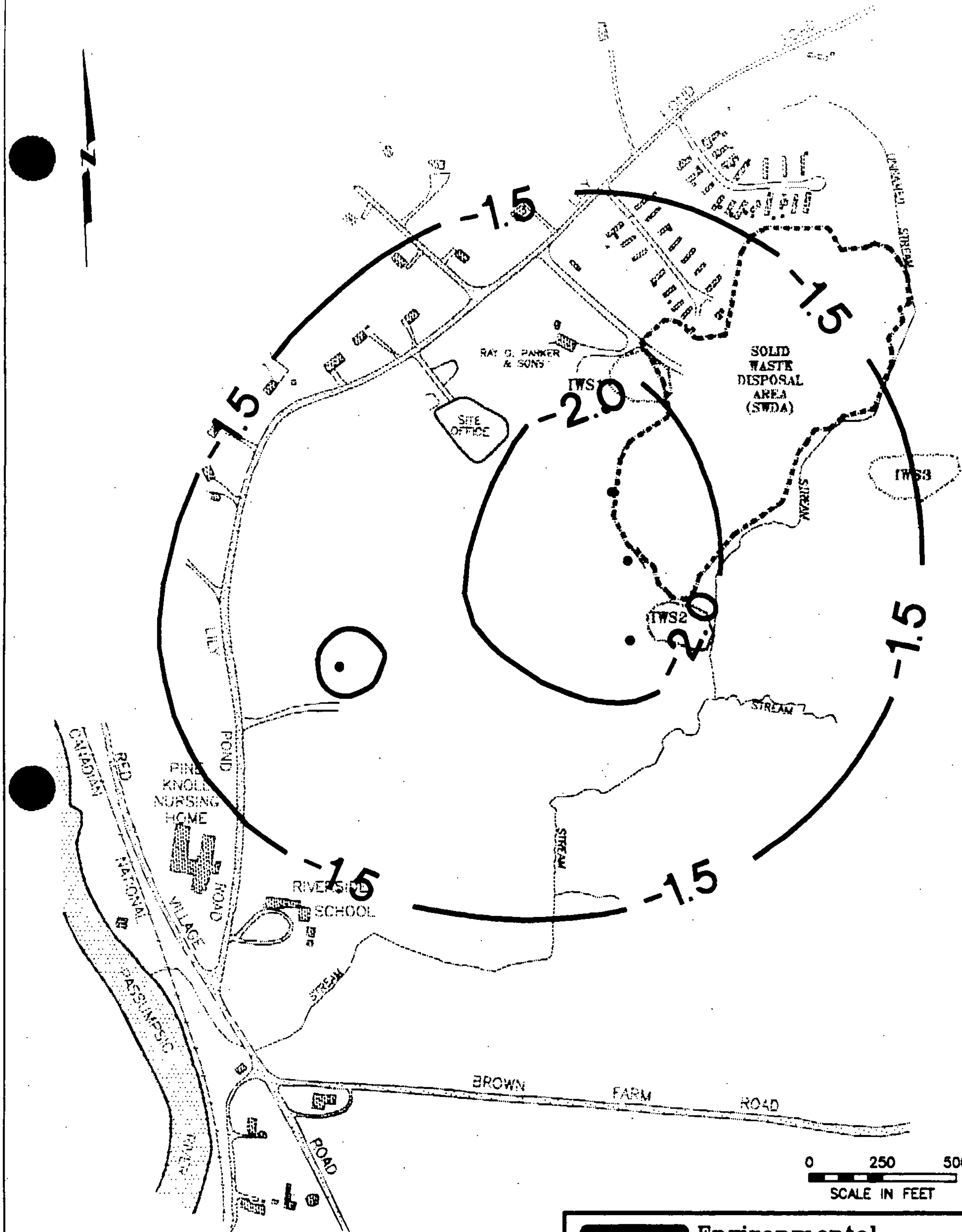
FIGURE 4-14

APPROXIMATE LOCATIONS OF SOURCE CONTROL AND MANAGEMENT OF MIGRATION GROUNDWATER EXTRACTION WELLS

DRAWING NAME: PWELL3.DWG		FILE NUMBER: 490 5024	
SCALE: AS SHOWN	REVISION: 0	DRAWN BY: PAD	DATE: 1/18/94



LEGEND

• GROUNDWATER EXTRACTION WELL

— -1.5 — DRAWDOWN (IN FEET)

NOTE:

BASE MAP FROM "TOPOGRAPHIC WORKSHEET OF THE PARKER LANDFILL", DATED SEPTEMBER 5, 1987, PROVIDED BY EASTERN TOPOGRAPHICS, WOLFBORO, NEW HAMPSHIRE, TO A SCALE OF ONE INCH EQUALS 100 FEET.

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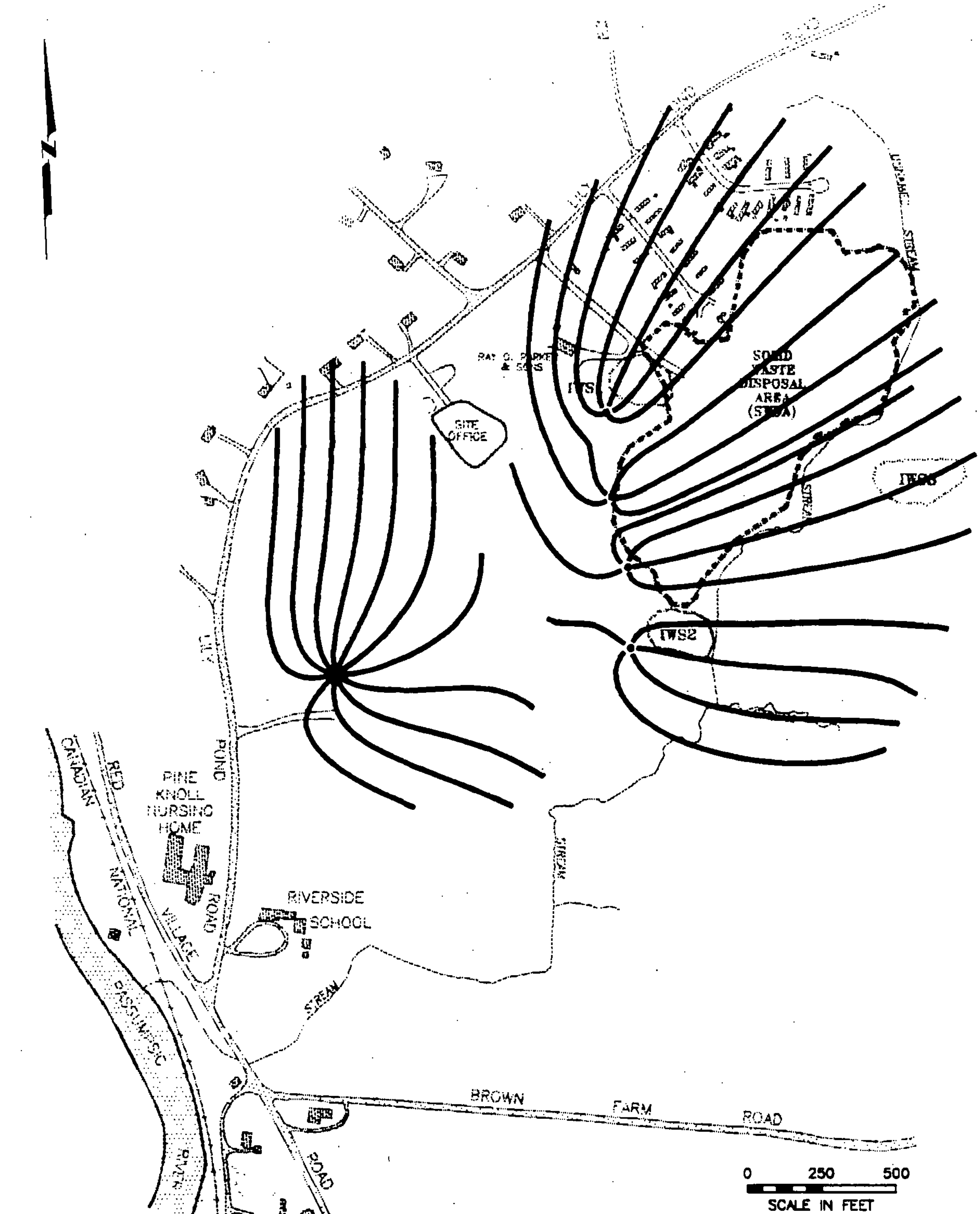
FIGURE 4–15

APPROXIMATE CONE OF INFLUENCE OF OVERBURDEN MANAGEMENT OF MIGRATION AND SOURCE CONTROL GROUNDWATER EXTRACTION WELLS

DRAWING NAME: DRAWDWN5.DWG		FILE NUMBER: 490 5024	
SCALE: AS SHOWN	REVISION: 0	DRAWN BY: PAD	DATE: 1/18/94



LEGEND

INDICATES APPROXIMATE CAPTURE ZONE OF PUMPING WELLS

NOTE:

BASE MAP FROM "TOPOGRAPHIC WORKSHEET OF THE PARKER LANDFILL", DATED SEPTEMBER 5, 1987, PROVIDED BY EASTERN TOPOGRAPHICS, WOLFBORO, NEW HAMPSHIRE, TO A SCALE OF ONE INCH EQUALS 100 FEET.

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FIGURE 4-16

APPROXIMATE CAPTURE ZONE OF OVERBURDEN SOURCE CONTROL AND MANAGEMENT OF MIGRATION GROUNDWATER EXTRACTION SYSTEM

DRAWING NAME: MIGRATN.DWG		FILE NUMBER: 490 5024	
SCALE: AS SHOWN	REVISION: 0	DRAWN BY: DJB	DATE: 1/18/94

TABLES

Table 1-1
Contaminants of Concern and Federal Drinking Water and Vermont Enforcement Standards
Parker Landfill Project
Feasibility Study

Name	MCL/MCLG(a) (mg/l)	Vermont Primary Groundwater Quality Standard (b) Enforcement Standard (mg/l)
Acetone	—	—
Benzene	0.005/0.0	0.005
2-Butanone	—	0.17
Chloroform	0.1	—
1,1-Dichloroethane	—	—
Dichlorodifluoromethane	—	—
1,2-Dichloroethane	0.005/0.0	0.005
1,1-Dichloroethene	0.007/0.007	0.007
1,2-Dichloroethene (total)	0.07/0.07(c)	0.07
Ethyl Benzene	0.7/0.7	0.68
Methylene Chloride	—	0.005
Tetrachloroethene	0.005/0.0	0.0007
Toluene	32142	2.42
1,1,1-Trichloroethane	0.2/0.2	0.2
Trichloroethene	0.005/0.0	0.005
Vinyl Chloride	0.002/0.0	0.002
Xylenes, Total	32425	0.4
Bis(2-Ethylhexyl)Phthalate	0.004/0.0	—
4-Methylphenol	—	—
Naphthalene	—	—

— Not Available

(a) - USEPA, Office of Water, "Drinking Water Regulations and Health Advisories", November 1991

(b) - Vermont Agency of Natural Resources, Department of Environmental Conservation, Groundwater Protection Rule and Strategy, September 29, 1988.

(c) - MCL is for cis-1,2-dichloroethylene.

File: Projects f/Parker f/FS f/Revised Table 1-1
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TABLE 1-2

Contaminants of Concern Contributing the Greatest
Carcinogenic Risk for Various Media

Parker Landfill Project
Feasibility Study

	GROUNDWATER	SEDIMENT	SOIL	AIR
Arsenic	■	■	■	
Benzene				■
Beryllium	■			
Tetrachloroethene	■			
Trichloroethene	■		■	■
Vinyl Chloride	■			

*Surface water was not considered a significant exposure route.

TABLE 1-3

Contaminants of Concern Contributing the Greatest
Noncarcinogenic Hazard for Various Media

Parker Landfill Project
Feasibility Study

	GROUNDWATER	SEDIMENT	SOIL	AIR
Arsenic	■	■		
Barium			■	
Chromium			■	
1,2-Dichloroethene	■			
Manganese	■			
4-Methylphenol	■			
Trichloroethene	■		■	
Vanadium			■	

*Surface water was not considered a significant exposure route.

Table 1-4

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04/22/94
Revision: 1

Summary of Estimated Carcinogenic Risks
Parker Landfill Project
Feasibility Study

MEDIA SOURCE	SOURCE LOCATION	RECEPTOR	EXPOSURE PATHWAY	TIME FRAME	RISK	
					AVERAGE	MAXIMUM
Groundwater	Site and Vicinity	Resident	Ingestion	Future	8E-04	2E-02
Groundwater	Residential Wells	Resident	Ingestion	Present/Future	8E-06	3E-05
Air	SWDA	Resident	Inhalation	Present/Future	5E-06	2E-05
Surface/Subsurface Soil	IWS Areas	Resident	Ingestion	Future	4E-06	7E-05
Sediment	Unnamed Stream	Resident	Ingestion	Future	2E-06	4E-04
Sediment	Unnamed Stream	Trespasser	Ingestion	Present	4E-07	7E-05
Surface Soil	SWDA	Trespasser	Ingestion	Present	3E-07	3E-06
Surface Soil	IWS Areas	Trespasser	Ingestion	Present	2E-07	1E-06
Surface/Subsurface Soil	IWS Areas	Resident	Dermal Contact	Future	8E-09	4E-05
Surface Soil	IWS Areas	Trespasser	Dermal Contact	Present	2E-10	2E-06
Surface Soil	SWDA	Trespasser	Dermal Contact	Present	4E-11	2E-11
Sediment	Unnamed Stream	Trespasser	Dermal Contact	Present	--	--
Sediment	Unnamed Stream	Resident	Dermal Contact	Future	--	--

* Shaded boxes represent unacceptable public health risk (USEPA Risk Assessment Guidance for Superfund, HHEM, July, 1989).

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Table 1-5

Summary of Estimated Noncarcinogenic Hazard Indices (HI)
Parker Landfill Site
Feasibility Study

MEDIA SOURCE	SOURCE LOCATION	RECEPTOR	EXPOSURE PATHWAY	TIME FRAME	HAZARD INDEX	
					AVERAGE	MAXIMUM
Groundwater	Site and Vicinity	Resident	Ingestion	Future	6E+00	5E+02
Surface/Subsurface Soil	IWS Areas	Resident (child)	Ingestion	Future	6E-01	2E+01
Sediment	Unnamed Stream	Resident (child)	Ingestion	Future	5E-02	6E+00
Surface/Subsurface Soil	IWS Areas	Resident (adult)	Ingestion	Future	3E-02	2E+00
Surface Soil	IWS Areas	Trespasser	Ingestion	Present	3E-02	4E-01
Groundwater	Residential Wells	Resident	Ingestion	Present/Future	9E-03	3E-01
Sediment	Unnamed Stream	Trespasser	Ingestion	Present	7E-03	9E-01
Sediment	Unnamed Stream	Resident (adult)	Ingestion	Future	5E-03	7E-01
Surface Soil	SWDA	Trespasser	Ingestion	Present	4E-03	4E-02
Air	SWDA	Resident	Inhalation	Present/Future	2E-03	7E-03
Surface/Subsurface Soil	IWS Areas	Resident (child)	Dermal Contact	Future	5E-04	3E+00
Surface/Subsurface Soil	IWS Areas	Resident (adult)	Dermal Contact	Future	1E-04	7E-01
Surface Soil	IWS Areas	Trespasser	Dermal Contact	Present	1E-05	1E-01
Surface Soil	SWDA	Trespasser	Dermal Contact	Present	9E-07	5E-07
Sediment	Unnamed Stream	Trespasser	Dermal Contact	Present	--	--
Sediment	Unnamed Stream	Resident	Dermal Contact	Future	--	--

* Shaded boxes represent unacceptable public health risk (USEPA Risk Assessment Guidance for Superfund, HHEM, July, 1989).

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TABLE 2-1
SWDA, IWS 1, IWS 2, AND IWS 3
REMEDIAL TECHNOLOGY IDENTIFICATION AND SCREENING
PARKER LANDFILL PROJECT
LYNDONVILLE, VERMONT

Response Measure/Technology	Process Option	Description	Technical Feasibility	Status
No Action				
No Action	———	SWDA and IWS Areas would be left as they currently exist.	Easily implemented.	NCP requires that this option be retained for comparative purposes. May be appropriate when risk associated with a response area is within the acceptable range or an alternative response may cause a greater environmental or health risk than no-action itself.
Management				
Fencing	Metallic mesh with barbed wire.	Limited existing fencing maintained. Additional fencing installed around SWDA and IWS Areas to limit access.	Fencing easily installed and maintained.	Potentially Applicable.
Institutional Controls	Deed Restrictions	Limitations on future use and activities to minimize the future potential risk of exposure to Contaminants of Concern and physical hazards.	Easily implemented.	Potentially Applicable.
Containment				
Capping	Solid Waste Cap	A solid waste cap would be designed to conform with the State of Vermont Solid Waste Regulations (and RCRA Subtitle D requirements). This cap would consist of a gas collection layer overlain by an impermeable liner (or impermeable soil layer), a fill layer and top soil, which would be vegetated.	Utilizes standard construction techniques. Capping with low permeability cover would require that potentially trapped gas be managed by venting or other means. Reconfiguration of the debris mass may be necessary to achieve appropriate slopes and drainage.	Not applicable, as EPA believes RCRA Subtitle C is an ARAR for the SWDA area. Not applicable for IWS Areas due to the disposal of industrial waste in these areas.
	Composite- Barrier Low- Permeability Cap. (Cap would comply with RCRA requirements).	A composite-barrier cap would be designed to conform with RCRA Subtitle C requirements. This cap would consist of a soil base layer, a geocomposite barrier layer, a drainage layer, soil fill layer, and a top soil layer, which would be vegetated.	Utilizes standard construction techniques. Capping the SWDA and IWS Areas with a low permeability cover may require that gas be managed by venting or other means.	Potentially Applicable.
Landfill Gas Collection	Pipe Vents	Pipe vents are used to vent combustible gas from accumulation points beneath cap to the atmosphere. Passive pipe vents are often connected.	Combustible gas vents are commonly installed at landfill sites, and utilize common construction techniques and personnel.	Potentially Applicable.
	Trench Vents	Trench vents are constructed by excavating a trench around the waste mass, and backfilling the trench with gravel to form a highly permeable zone through which combustible gas migrates and vents to the atmosphere. Trench vents are most effective where downward migration of gas is limited by groundwater or other relatively impermeable layer.	Depth to the water table varies from approximately 20 to 125 feet and, therefore, trench vents could not be constructed to ensure gas migration is controlled.	Not feasible due to construction difficulties.

N/A - Not Applicable
*Cost relative to other process options within the same technology type.

TABLE 2-1
SWDA, IWS 1, IWS 2, AND IWS 3
REMEDIAL TECHNOLOGY IDENTIFICATION AND SCREENING
PARKER LANDFILL PROJECT
LYNDONVILLE, VERMONT

Response Measure/Technology	Process Option	Description	Technical Feasibility	Status
Landfill Gas Collection (cont'd)	Extraction Wells	Extraction wells are installed through waste material, manifolded together, and pumped to withdraw combustible gas from the waste. Systems are typically connected to a flare system to burn the combustible gas.	Utilizes standard construction and installation techniques. Construction equipment and personnel readily available.	Potentially Applicable.
	Air Injection	Similar to the system described for extraction wells, only air is blown into the wells instead of being pumped out. As a result, combustible gas is diluted or forced away from the area where the wells are located.	May be difficult to implement due to injection well location, spacing requirements, and heterogeneous nature of SWDA and IWS Areas. Potential adverse impacts to adjacent trailer park.	Not feasible.
Landfill Gas Treatment/ Monitoring	Enclosed Ground Flares	Enclosed ground flare systems are constructed of fire brick, and are used to contain and burn combustible gas withdrawn from an extraction system. May require supplemental fuel to provide for continuous ignition.	Would thermally destroy combustible gas and some associated constituents. May require supplemental fuel to maintain continuous burning.	Potentially Applicable.
	Adsorption/Scrubbing	Combustible gas is vented through moisture traps and then adsorption vessels packed with GAC and/or other odor-reducing materials, such as iron scrubbers to remove hydrogen sulfide.	Adsorption/scrubbing systems utilize conventional equipment. Fire/explosion control instrumentation would be added. Contaminants are concentrated, rather than destroyed. A GAC system would require pumping the gas through packed carbon vessels.	Potentially applicable.
	Monitoring	Monitoring points installed into the SWDA and IWS Areas would provide for easy monitoring of combustible gas concentrations beneath the caps.	Utilizes standard installation techniques. Equipment and personnel readily available.	Potentially Applicable.
In-Situ Treatment				
IWS 2 ONLY An analysis of the significance of the IWS Areas as "hot spots" indicates that, in accordance with EPA's *Guidance For Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites*, only IWS 2 should be considered for removal and/or disposal/treatment measures and technologies.	Vacuum Extraction	Volatile organic compounds are removed via an airflow which is induced through the unsaturated zone. Constituents which are removed undergo off-gas treatment.	Effective at reducing VOC. However, sufficient air flow through the soil/waste may not be achieved due to the heterogeneity of soils and debris. Channeling would occur and VOC may not be effectively removed from some zones. Only appropriate for unsaturated or dewatered materials. PAH compounds, metals, and phthalates detected in IWS 2 Area would not be significantly removed by vacuum extraction.	Potentially Applicable in IWS 2. Must be used in conjunction with off-gas treatment.

N/A - Not Applicable
*Cost relative to other process options within the same technology type.

TABLE 2-1
SWDA, IWS 1, IWS 2, AND IWS 3
REMEDIAL TECHNOLOGY IDENTIFICATION AND SCREENING
PARKER LANDFILL PROJECT
LYNDONVILLE, VERMONT

Response Measure/Technology	Process Option	Description	Technical Feasibility	Status
In-Situ Treatment IWS 2 ONLY (cont'd)	Bioremediation	Materials containing organic constituents are inoculated with both nutrients and microorganisms which promote the biodegradation of these compounds. May include bioventing and/or sparging.	IWS 2 Area contains fine textured soils which may negatively impact bioremediation success. Metals are not significantly reduced and could inhibit the biological process.	Not feasible due to presence of metals and inability to ensure treatment throughout the IWS 2 Area.
	Vitrification (ISV)	Process whereby organic and inorganic Contaminants of Concern are stabilized/solidified in place using heat generated by large electrodes in the presence of significant levels of silicates. Contaminants of Concern are either oxidized or encapsulated in the melted silicates which would form a siliceous glass mass when cooled.	Currently all commercial work on ISV has been halted due to a fire that occurred at another CERCLA site.	Not feasible because all commercial work on ISV has been halted.
	Soil Flushing	Clean water, sometimes with surfactants, is injected or irrigated to flush constituents from the soil. A contaminant capture system is required, such as extraction wells or trenches with containment barriers.	Soil flushing is an effective treatment for only a small number of Contaminants of Concern. Volatile and highly insoluble materials such as some SVOC are not appropriately treated with this technology. Utilization would require using multiple technologies. Relatively impermeable soils inhibit soil flushing surface distribution and ability to effectively control the flushing treatment. Increased irrigation by flushing may spread contaminants.	Not feasible due to implementation difficulties.
	Electrolysis/Electro-Kinetics	Electrical charge is applied through the soil between anodes and cathodes. Conductive soluble chemicals are driven to one electrode and extracted in collection wells.	Application in variable material is unproven. Performance documentation is difficult. Electrical and explosion hazards may occur.	Not feasible for waste types present.
	Steam/Hot Water Sparging	Steam and/or hot water is injected causing some Constituents to migrate to controlled collection points or areas such as extraction wells or interception trenches.	Control of steam/hot water dispersion would be difficult in fill areas and heterogeneous soils. High temperatures may inhibit biological degradation. Hazardous gaseous byproducts may be generated by high temperature. Relatively impermeable soils may inhibit the effectiveness of sparging.	Not feasible for waste types present.
	Solidification/Stabilization (S/S)	Soil and solid waste are mixed with S/S agents to create an inert mass from which hazardous constituents would not be able to migrate.	Adequate mixing of soil and solid waste with S/S agents is extremely unlikely due to the presence of various large objects within the IWS 2 Area.	Inappropriate technology due to the inability to achieve adequate mixing of waste with S/S agents.

N/A - Not Applicable
*Cost relative to other process options within the same technology type.

TABLE 2-1
SWDA, IWS 1, IWS 2, AND IWS 3
REMEDIAL TECHNOLOGY IDENTIFICATION AND SCREENING
PARKER LANDFILL PROJECT
LYNDONVILLE, VERMONT

Response Measure/Technology	Process Option	Description	Technical Feasibility	Status
Removal				
Excavation IWS 2 ONLY (See above discussion)	Excavation of Hot Spots	Excavation of IWS 2.	"Hot spots that are appropriate for excavation and removal should be in discrete, accessible locations of a landfill where a waste type or mixture presents a principal threat to human health or the environment. The area should be large enough so that remediation will significantly reduce the risk posed by the overall site and small enough to be reasonably practicable for removal and/or treatment..."(EPA, 1991a). RI soil data indicate that IWS 1 and 3 are not presently primary sources of Contaminants of Concern, and therefore, excavation of IWS 1 or 3 materials as "hot spots" would not be appropriate. Excavation of IWS 2 materials would be technically feasible, although there would be significant health and safety concerns associated with material handling. Should excavation of saturated materials be required, temporary dewatering would be necessary. Depending on the depth of excavation and degree of dewatering necessary, this may be difficult to implement.	Potentially Applicable to IWS 2 material.
Dewatering	——	Pumping of wells to lower groundwater table under materials known to contain constituents above remediation goals, so contaminated material would not be in contact with groundwater; or to dewater materials during excavation.	Dewatering of materials for an extended period of time would be very difficult to implement due to the high groundwater pumping rates that would have to be maintained. Therefore, dewatering to minimize direct leaching of constituents to groundwater or to allow vapor extraction of VOC from materials that are currently below the water table would not be technically feasible. Temporary dewatering associated with material excavation should be technically feasible; however, depending on the depth of excavation and degree of dewatering necessary, this may prove difficult to implement. All water removed would require appropriate treatment and disposal.	Due to the high flow rate that would need to be sustained to achieve dewatering of all impacted materials, dewatering is eliminated from further consideration, except for temporary dewatering during excavation.
Disposal of Excavated Materials	Consolidation	Contaminated material excavated from IWS 2 would be consolidated and placed beneath the cap constructed on IWS 1 or 3. "A common disposal option for outlying hot spots in municipal landfill sites is consolidation with other landfill material followed by capping. Consolidation may also be a practicable alternative for disposal of wastes in undesirable locations (for example, wetlands) or contaminated sediments." (EPA, 1991a).	Excavation and consolidation of IWS 2 material should be technically feasible, although the benefits would be minimal, since all of the waste material and soil with higher levels of contamination is located in the unsaturated zone and would be isolated beneath a cap over IWS 2. There would be significant health and safety considerations associated with material handling.	Potentially Applicable for IWS 2 material.

N/A - Not Applicable
*Cost relative to other process options within the same technology type.

TABLE 2-1
SWDA, IWS 1, IWS 2, AND IWS 3
REMEDIAL TECHNOLOGY IDENTIFICATION AND SCREENING
PARKER LANDFILL PROJECT
LYNDONVILLE, VERMONT

Response Measure/Technology	Process Option	Description	Technical Feasibility	Status
Disposal of Excavated Materials (cont'd)	Off-Site RCRA Facility	Excavated contaminated material which is determined to be a RCRA waste would be disposed of off-site at a RCRA facility.	Contaminated materials may require treatment prior to disposal, based on land disposal requirements. Off-site RCRA disposal without treatment does not reduce toxicity, mobility, or volume of waste, but transfers potential exposure risks to another site. High worker safety, dust emissions, transportation, and traffic safety risks.	Potentially Applicable for IWS 2 material.
	On-Site RCRA-Design Landfill	Contaminated material would be excavated and disposed of on-site in a RCRA-design landfill which would consist of a double liner base, leachate detection and collection system, a low permeability cap, and groundwater monitoring.	Implementation of a RCRA design disposal facility for approximately 2,000-3,000 yd^3 of material would require extensive construction staging areas and would change the site topography. Relatively shallow groundwater and bedrock in the area would minimize the areas available for landfill construction.	Eliminated from further consideration. Small volume of excavated material does not warrant construction of a separate RCRA design landfill.
Ex-Situ Treatment				
Incineration: Commercial Off-Site:	——	Incineration is used to destroy Contaminants of Concern. Incineration processes typically maintain soils at temperatures between 1,200°F and 2,000°F. Ash residue, typically considered a hazardous waste, is produced. The closest currently-available commercial incinerator to the landfill is in New Jersey. Depending on the requirements of the individual incineration facility, transport as far as Texas may be required.	Hazardous waste material handling and long distance transport would be required. Sorting and removal of large items may be required. Virtually all organic compounds are destroyed. Incineration is not effective at eliminating metals. Some metals may become volatilized, requiring air emissions capture systems. Residual metals may present a disposal problem.	Potentially Applicable for IWS 2 material.
Incineration: On-Site	——	Destroys organics at high temperatures. Several process options such as Rotary Kiln Incinerator, Circulating Bed Combuster, Infrared Destruction, and Advanced Electric Reactor are available.	The units are transportable. Sorting and removal of large items may be necessary. Residual metals may present a disposal problem. Mobile incinerators are available for on-site use. However, the volume of material within IWS 2 is insufficient to support on-site incineration.	Not feasible for IWS 2 material due to small volume of material.
Solidification/Stabilization	Soil Binding	Solidification and/or stabilization agents, such as lime, cement kiln dust, cement pozzolan polymers, and organophillic clays, are mixed with contaminated soil to bind the contaminants and reduce the potential for contaminant migration.	The long-term stability of treated soil mixtures containing VOC is not well documented. Contaminants are not destroyed, but retained. Solidification/stabilization is only applicable for very homogeneous mixtures of contaminants. Extensive mixing and trial testing is required.	Not feasible due to the heterogeneity of materials, wide range of Contaminants of Concern present in IWS 2 and potential long-term effectiveness concerns associated with stabilization of VOC.
Soil Washing	——	Soil washing reduces the volume of contaminated material by separating very fine highly-contaminated particles from coarser sand and gravel. The finer particles are then treated.	Requires extensive materials handling. Substantial residual contaminated material would remain.	Not feasible for soil types present in IWS 2 because substantial residual contaminated material would remain.

N/A - Not Applicable
*Cost relative to other process options within the same technology type.

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TABLE 2-1
SWDA, IWS 1, IWS 2, AND IWS 3
REMEDIAL TECHNOLOGY IDENTIFICATION AND SCREENING
PARKER LANDFILL PROJECT
LYNDONVILLE, VERMONT

Response Measure/Technology	Process Option	Description	Technical Feasibility	Status
Thermal Desorption	——	Low temperature direct or indirect heating is used to volatilize organics, which are subsequently destroyed in an afterburner. Thermal desorption systems typically operate to maintain soil temperatures in the range of 500°F to 1,200°F. Afterburner gas streams are typically maintained at temperatures in the range of 1,200°F to 1,800°F. Thermal desorption systems may be based on rotary dryers, thermal screws, conveyor furnaces or other devices; purge gases used include air, nitrogen, a combustion gas, or other inert gas.	Temperature cannot exceed the flash point of any constituent present. Requirements for control of vaporized metal emissions is less than for high-temperature incineration. There are several vendors of commercially available fixed and portable thermal desorption systems, although these units would not be feasible for the volume of material present in IWS 2. Thermal desorption does not completely destroy some types of organics, including some PAHs, halogenated cyclic aliphatics, ethers, esters, and ketones; phenols, and some aromatics. Metals are not significantly affected, and would be a concern in the treatment residue.	Not feasible for IWS 2 material due to insufficient volume.
Solvent Extraction	General	Liquified gases or organic solvents are used to extract organics and oily wastes from excavated soils and sludges. Gases or solvents are reclaimed on-site and concentrated extract is shipped off-site for treatment or disposal. Continuous units usually consist of several extractors in series. Alternatively, batch units may be used.	Continuous systems require relatively constant feed conditions and result in more residuals. Extensive soil staging and blending would be required for solvent extraction to be effective due to the heterogeneous nature of fill material and highly variable constituent concentrations. Batch units can handle relatively variable feed conditions and have better extraction efficiencies. Discussion with solvent extraction vendors indicates that on-site solvent extraction would not be feasible for volumes $<10,000$ yd^3.	Not feasible due to inadequate volume of material.
Chemical Dechlorination	——	Chemical dechlorination involves the substitution of the chlorine atoms present in organic constituents with other atoms from a synthesized chemical reagent.	Commercial systems such as KPEG® and APEG® are available. Would reduce some chlorinated organic compounds, but not other organics and metals.	Not feasible for constituents present in IWS 2.
Biological Treatment	——	Biological treatment involves the molecular breakdown of organic substances by living organisms. Excavated contaminated material is mixed with nutrients in remediation basins or cells.	Requires construction of lined basins for mixing; Requires long time period (e.g., three to ten years). Open mixing of material would release volatiles to the atmosphere. Fine textured soils inhibit the effectiveness of bioremediation.	Not feasible due to the presence of metals and very fine soils which may inhibit the effectiveness of biological treatment.

N/A - Not Applicable
*Cost relative to other process options within the same technology type.

TABLE 2-2
GROUNDWATER
REMEDIAL TECHNOLOGY IDENTIFICATION AND SCREENING
PARKER LANDFILL PROJECT
LYNDONVILLE, VERMONT

Response Measure/Technology	Process Option	Description	Technical Feasibility	Status
No Action				
No Action	______	Natural biodegradation and chemical decomposition of organic constituents would occur.	Easily implemented.	Potentially Applicable. May be appropriate when risk is within acceptable range or an alternative response may cause a greater environmental or health danger than no-action itself.
Management				
Institutional Controls	Deed Restrictions Local Regulations	Restrictions placed on well installations and usage within the area that contains Contaminants of Concern associated with the SWDA and/or IWS Areas at concentrations above drinking-water standards.	Easily implemented.	Potentially Applicable.
Monitoring	______	Periodic monitoring of groundwater conditions conducted.	Easily implemented	Potentially Applicable.
Containment/Isolation				
Vertical Barriers	Slurry Walls	A subsurface barrier to groundwater flow is constructed by excavating a trench and backfilling with a soil/bentonite/water "slurry".	Significant implementability concerns associated with installation of effective downgradient barrier to depth of between 100 and 250 feet. Partially penetrating barrier could be installed, but would not significantly reduce groundwater flow or extraction rates.	Not feasible for upgradient or downgradient groundwater diversion or containment.
	Sheet Piling	Sheet pilings with interlocking joints are installed with a drop or vibratory hammer to form a subsurface groundwater flow barrier.	Significant implementability concerns associated with installation of effective downgradient barrier to depth of between 100 and 250 feet. Partially penetrating barrier could be installed, but would not significantly reduce groundwater flow or extraction rates.	Not feasible for upgradient or downgradient groundwater diversion or containment.
	Grout Curtains	A subsurface barrier to groundwater flow is constructed by filling a series of adjacent, overlapping boreholes with impermeable material.	Significant implementability concerns associated with installation of effective downgradient barrier to depth of between 100 and 250 feet. Partially penetrating barrier could be installed, but would not significantly reduce groundwater flow or extraction rates.	Not feasible for upgradient or downgradient groundwater diversion or containment.
In-Situ Treatment				
	Biological Degradation	Organic material is biologically degraded by aerobic microorganisms in the groundwater and soil assisted by the injection of nutrients, chemical energy (e.g., air, oxygen), and possibly pH adjustment chemicals.	Intermediate degradation products may be more toxic than original compounds. Metals would not be significantly reduced and may inhibit the biological degradation process. In-situ treatment would be very difficult to effectively implement due to the low permeability of the soils.	Not feasible due to the presence of metals and low permeability soils.

N/A - Not Applicable

TABLE 2-2
GROUNDWATER
REMEDIAL TECHNOLOGY IDENTIFICATION AND SCREENING
PARKER LANDFILL PROJECT
LYNDONVILLE, VERMONT

Response Measure/Technology	Process Option	Description	Technical Feasibility	Status
In-Situ Treatment (cont'd)				
	Chemical Degradation	Oxidants such as hydrogen peroxide, ozone, and other chemicals are pumped in to the groundwater to oxidize organic constituents to terminal or intermediate products that are more readily biodegradable or removable by adsorption. Other chemicals may be required to maintain correct pH range.	There are numerous technical concerns involving the injection of additional chemicals into the aquifer. Hydraulic control to ensure even distribution and containment of the added chemicals may be very difficult to achieve. Metals would not be removed.	Not feasible due to the technical concerns associated with effective control of the added chemicals and ability to ensure even distribution.
Withdrawal/Collection				
Groundwater Extraction	Extraction Wells	Groundwater extraction wells would be used to prevent migration of constituents.	Installation of extraction wells utilizes conventional well installation techniques. Experienced personnel are available. The need for installation of additional extraction wells would depend upon the results of hydraulic analyses evaluating the use of existing monitoring wells as extraction wells.	Potentially Applicable.
	Interceptor Trench	Perforated drain lines are buried in trenches to intercept groundwater at a boundary. May or may not include pumping.	Trench drains are installed with conventional equipment or, depending on the depth, may be installed using surface-mounted equipment. Trench drains are effective in intercepting contaminated groundwater where the vertical distribution is well known and confined to a relatively shallow and narrow stratum. Due to the thickness of the aquifer (approximately 140 feet), trench drains would only intercept groundwater from the upper portion and therefore, are not appropriate.	Not feasible.
	Sparge and Vent	Air is pumped into the soil below the groundwater table and beneath the contamination and subsequently vented through a system of probes to the surface. Venting is sometimes assisted by vacuum pumps.	Although this technology can be effective for removal of volatile contaminants, sparge and vent would be difficult to implement in low permeability soils. Subsurface obstructions could impact gas flow and there is some risk of further horizontal spreading of contaminants. Would not be effective for removal of PAH or metals.	Not feasible.
Ex-Situ Groundwater Treatment				
	Granular Carbon Adsorption	Extracted groundwater would be pumped through a series of columns containing granular activated carbon (GAC). Organic constituents would be adsorbed from the aqueous-phase onto the surface of the GAC particles. The GAC would require periodic replacement or regeneration.	Carbon adsorption is commonly used to remove organic constituents from both wastewater and drinking water supplies. Aqueous-phase carbon adsorption systems are widely available.	Potentially Applicable.

N/A - Not Applicable

TABLE 2-2
GROUNDWATER
REMEDIAL TECHNOLOGY IDENTIFICATION AND SCREENING
PARKER LANDFILL PROJECT
LYNDONVILLE, VERMONT

Response Measure/Technology	Process Option	Description	Technical Feasibility	Status
Ex-Situ Groundwater Treatment (cont'd)				
	Air Stripping	Extracted groundwater would be pumped through either a countercurrent packed tower aeration system or an induced draft air stripper. VOC would be transferred to the vapor phase. If off-gases exceed Vermont Department of Environmental Conservation (DEC) action levels for the Contaminants of Concern, off-gas treatment with vapor-phase activated carbon would be required.	Air stripping is commonly employed to remove low level volatile organic constituents from groundwater. Air strippers are widely available. Air controls (GAC, thermal incineration, or catalytic conversion) may be required if constituents in effluent gases exceed Vermont DEC action levels.	Potentially Applicable.
	Biological	Extracted groundwater would be pumped to above-ground bioreactors where microorganisms metabolize organic constituents into innocuous end products such as cellular material, carbon dioxide, and water. Adsorption and gravity settling assist in the removal process. Biological treatment may involve suspended-growth or fixed film systems. Both continuous-flow and batch-reactor treatment systems are available. Typical systems involve some variation of activated sludge process. Sludge generated as a by-product would require disposal.	Dissolved metals are not significantly removed by biological treatment processes. In addition, metals at higher concentrations such as some of those in the Study Area groundwater could cause toxic inhibition of the treatment process. Pretreatment for reduction of metals may be necessary. After such metals pretreatment, remaining concentrations of organic constituents may be too low to sustain biological treatment activity, unless nutrients were added.	Potentially feasible. Following metals pretreatment, remaining concentrations of organic constituents may be too low to sustain biological treatment activity, unless nutrients added.
	Powdered Activated Carbon Treatment (PACT®)	PACT® is a hybrid technique combining several treatment mechanisms. Extracted groundwater would be treated in mixing tanks into which powdered activated carbon is added. Biological activity is promoted, in part as an attached-growth phenomenon, with the suspended carbon particles providing the attachment surface. Treatment occurs by a combination of air stripping, biological activities (both suspended and attached), adsorption, and settling.	Being a biological treatment system, PACT® is susceptible to toxic inhibition by high concentrations of metals; however, not to the extent that a straight biological system would be. Pretreatment to reduce metals may result in a stream low in organics.	Potentially feasible for contaminants present in groundwater.
	Chemical Oxidation	Constituents in water are oxidized to less toxic compounds by the application of an oxidizing agent such as ozone, chlorine, or hydrogen peroxide.	Some, but not all, organic constituents are destroyed. Chemical Oxidation is not significantly effective in destroying constituents such as phthalates, 1,1,1-TCA, phenols, and toluene. Some PAH compounds, such as fluoranthene, are difficult to destroy with chemical oxidation. Metals may precipitate and would require removal. In some cases, more toxic organic compounds may form.	Not feasible for contaminants present in groundwater such as phthalates, 1,1,1,-TCA, phenols, and toluene.

N/A - Not Applicable

TABLE 2-2
GROUNDWATER
REMEDIAL TECHNOLOGY IDENTIFICATION AND SCREENING
PARKER LANDFILL PROJECT
LYNDONVILLE, VERMONT

Response Measure/Technology	Process Option	Description	Technical Feasibility	Status
Ex-Situ Groundwater Treatment (cont'd.)				
	UV Oxidation	Extracted groundwater is pumped through ultraviolet light chambers. Pretreatment, such as filtering, may be required. UV oxidation is sometimes coupled with ozone oxidation, or with hydrogen peroxide addition.	UV oxidation is effective at reducing some chlorinated and non-chlorinated organics, and can precipitate some dissolved metals, reducing their mobility. UV oxidation is not effective for other Contaminants of Concern present in the groundwater, including 1,1-DCA, 1,1,1-TCA, methylene chloride, and 1,2-DCE. Performance is significantly affected by contaminant stream conditions. UV equipment is susceptible to fouling and maintenance problems when treating water with significant concentrations of metals and other inorganics. Presence of metals also inhibits organics removal.	Not feasible for contaminants present in Study Area groundwater, such as 1,1,1 DCA, 1,1,1-TCA, methylene chloride, and 1,2-DCE.
	Hydroxide/ Carbonate Precipitation	Lime or sodium hydroxide is used to remove metals from groundwater via pH adjustment, precipitation, flocculation, and settling. Filtering is often used after settling.	Hydroxide/carbonate precipitation uses readily available and proven technology, and is effective in removing most metals to the 100-200 ug/l range. This treatment may also lower concentrations of organic contaminants.	Potentially Applicable.
	Sulfide Precipitation	Similar process as hydroxide carbonate precipitation, but very insoluble metal sulfides are precipitated out. The process involves pH adjustment and addition of soluble NaHS or insoluble FeS slurry.	Sulfide precipitation is effective in removing most metals from groundwater to < 10 ug/l. Potentially hazardous metal sulfide sludge is generated, which would require dewatering and appropriate disposal.	Potentially Applicable.
	Ion Exchange	Water is pumped through ion exchange vessels containing anionic or cationic resins selected to exchange specific dissolved metals, which are retained in the resin bed until the bed is exhausted. Vessels are periodically backwashed and regenerated with acid, base or salt solution.	Ion exchange units are readily available and proven for removal of metals from groundwater. Operation is simple and relatively neat. Concentrated regeneration wastes are produced.	Potentially Applicable.
	Reverse Osmosis	Pressure is applied to water in a vessel to force less contaminated water across a membrane, resulting, after successive separations, in a highly concentrated waste solution (concentrate) and a purified stream (permeate).	Reverse osmosis membranes are selectively effective in removing some, but not all, of the organic and inorganic Contaminants of Concern. Pretreatment, such as filtration and chemical addition, may be required.	Not feasible for all constituents present in groundwater.
	Ultrafiltration	Water is pressurized across a selective membrane designed to retain particles and molecules above a specific size or molecular weight. This is often accomplished in a membrane tube configuration. Retained contaminants (concentrate) wash down to waste.	Ultrafiltration is effective for removing inorganics and organics over a wide range, but not all Contaminants of Concern. Fouling may be a problem.	Not feasible for all constituents present in groundwater.

N/A - Not Applicable

TABLE 2-2
GROUNDWATER
REMEDIAL TECHNOLOGY IDENTIFICATION AND SCREENING
PARKER LANDFILL PROJECT
LYNDONVILLE, VERMONT

Response Measure/Technology	Process Option	Description	Technical Feasibility	Status
Discharge of Extracted/Treated Groundwater				
Direct Discharge to Surface Water	Outfall pipeline to the Passumpsic River or Unnamed Stream	Treated groundwater would be discharged to the nearest suitable surface water, the Passumpsic River or unnamed stream, by a combination of pumped force main and gravity outfall pipeline.	A surface discharge could be easily implemented and operated. For discharge to the Passumpsic River, an outfall pipeline would be required. The outfall pipeline would be long (approximately 1/2 mile) and would require significant construction costs. NPDES discharge permit would be required and effluent limits met. Discharge into the unnamed stream would require a much shorter pipeline but may entail more stringent effluent limits.	Potentially Applicable.
Discharge to Sewer/POTW	———	There is a publicly owned treatment works (POTW) in Lyndonville located approximately one-quarter mile south of the town center. However, the closest potential sewer line connection is located approximately two miles north of the Parker Landfill on Hill Street.	Due to the distance to the nearest potential sewer line connection, discharge to the sewer/POTW would be extremely difficult and costly.	Not feasible for discharge of treated groundwater.
Reinjection	———	Groundwater would be reinjected into the subsurface after treatment.	Reinjection wells could be easily installed. Clogging may occur if water is not treated sufficiently. Injection well screen clogging, and the associated reduction in reinjection rates, is a commonly observed problem that can significantly increase maintenance costs. Reinjection system must be designed to eliminate short cycling.	Potentially Applicable.

N/A - Not Applicable

TABLE 2-3
SWDA, IWS 1, IWS 2, AND IWS 3
EVALUATION OF TECHNOLOGY PROCESS OPTIONS
PARKER LANDFILL PROJECT
LYNDONVILLE, VERMONT

Response Measure/Technology	Process Option	Description	Effectiveness	Implementability	Cost *	Status/Justification
No Action						
No Action	———	———	Some natural degradation of organic constituents would occur, but no significant net reduction in metals would occur. No measures would be taken to address the potential for the SWDA and IWS Areas to contribute constituents greater than the remediation goals to the groundwater.	Easily implemented.	N/A	Retained due to: • Provides basis for comparison with other options. • Required by the NCP.
Management						
Fencing	Metallic Mesh with Barbed Wire	Limited existing site fencing maintained. Additional fencing installed to surround SWDA and IWS Areas to limit site access.	Fencing would effectively limit direct contact with soil and solid waste.	Existing site fencing easily maintained or replaced. Additional fencing easily installed and maintained.	Low Capital Low O&M	Retained due to: • Effectively prevents direct contact with soils and solid waste.
Institutional Controls	Deed Restrictions	Limitations on future use and activities to minimize the future potential risk of exposure to contaminants and physical hazards.	Deed restrictions would effectively regulate future use of the Landfill.	Easily implemented.	Low Capital No O&M	Retained due to: • Minimizes future potential risk of exposure to contaminants.
Containment Capping						
	Composite-Barrier Low-Permeability Cap	A composite-barrier cap would be designed to conform with RCRA Subtitle C requirements and would consist of a soil base layer, a geocomposite-barrier layer, an impermeable liner, a drainage layer, soil fill layer, and a top soil layer, which would be vegetated.	A layered cap design would be more effective than a solid waste cap in reducing infiltration through use of an additional barrier layer.	Utilizes standard construction techniques. Capping with low permeability cover would require that gas be managed by venting or other means.	High Capital Moderate O&M	Retained due to: • EPA considers certain requirements of RCRA (specifically subparts F, G and N) as relevant and appropriate for the SWDA and IWS Areas. • Hazardous materials were disposed within the IWS Areas.

N/A - Not Applicable
*Cost relative to other process options within the same technology type.

TABLE 2-3
SWDA, IWS 1, IWS 2, AND IWS 3
EVALUATION OF TECHNOLOGY PROCESS OPTIONS
PARKER LANDFILL PROJECT
LYNDONVILLE, VERMONT

Response Measure/Technology	Process Option	Description	Effectiveness	Implementability	Cost *	Status/Justification
Landfill Gas (LFG) Collection	Pipe Vents	Pipe vents are used to vent gas from accumulation points beneath the cap to the atmosphere. Passive pipe vents are often connected. The passive collection system may be connected to a central flaring station if monitoring indicates destruction of the gas is necessary.	Pipe vents installed through the IWS caps would provide for adequate venting of subsurface gas that may build up beneath the cap.	Gas vents are commonly installed at landfill sites, and utilize common construction techniques and personnel.	Low Capital Low O&M	Not retained as representative process: ● One or more process options may be selected to represent a technology type in order to simplify the subsequent and evaluation of alternatives without limiting flexibility during remedial design. Not retained for SWDA or IWS Areas: ● Due to the amount of methane gas expected within the SWDA, flaring will likely be required. ● Due to the size of the RCRA cap, an active collection system and centrally located flaring station may be more cost effective and more easily implemented than the numerous individual gas flaring stations necessary with a passive system.
	Extraction Wells	Extraction wells are installed through waste material, manifolded together, and pumped to withdraw LFG from the waste. Systems are typically connected to a flare system to burn the methane gas.	Active extraction system would provide for additional removal of LFG over passive venting. However, would require higher capital and O&M expenditures.	Utilizes standard construction and installation techniques. Construction equipment and personnel readily available.	Moderate Capital Moderate O&M	Retained for SWDA and IWS Areas due to: ● Applicable technology for recently closed landfills with potential for increased gas production.
LFG Treatment	Enclosed Ground Flares	Enclosed ground flare systems are constructed of fire brick, and are used to contain and burn LFG withdrawn from an extraction system. May require supplemental fuel to provide for continuous ignition. LFG is collected and piped to a central flaring station.	Would thermally destroy LFG and some associated contaminants. Collection and central flaring station would minimize potential LFG odors.	Specialized construction equipment and personnel readily available.	Moderate Capital Moderate O&M	Enclosed ground flares retained as representative process option due to: ● Applicable technology for recently closed landfills with potential for increased gas production.

N/A - Not Applicable
*Cost relative to other process options within the same technology type.

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TABLE 2-3
SWDA, IWS 1, IWS 2, AND IWS 3
EVALUATION OF TECHNOLOGY PROCESS OPTIONS
PARKER LANDFILL PROJECT
LYNDONVILLE, VERMONT

Response Measure/Technology	Process Option	Description	Effectiveness	Implementability	Cost *	Status/Justification
LFG Treatment (cont)	Adsorption/ Scrubbing	Combustible gas is vented through moisture trays and then adsorption vessels packed with GAC and/or other odor-reducing materials.	Adsorption/scrubbing would effectively remove methane and other volatile organic compounds.	Adsorption/scrubbing could be implemented using specialized construction equipment. Personnel readily available.	High Capital High O&M	Not retained as representative process option.
	Monitoring	Monitoring wells installed into the SWDA would provide for easy monitoring of LFG concentrations beneath the cap.	Would provide a ready means of determining the presence and concentration of LFG beneath the cap, and may be used in a passive or active venting system.	Utilizes standard installation techniques. Equipment and personnel readily available.	Low Capital Low O&M	Retained due to: • Provides for monitoring of LFG. • Appropriate technology and process option.
In-Situ Treatment (IWS 2 only)						
Vacuum Extraction	—	Organic Contaminants of Concern are removed via an airflow which is induced through the unsaturated zone. Constituents which are removed undergo off-gas treatment.	Would remove VOC from IWS 2 materials. Subsurface conditions (i.e., low soil permeability, metallic objects, etc.) would significantly impact the implementability and, therefore, the effectiveness of this technology at IWS 2. In addition, PAH compounds, phthalates, and metals detected in IWS 2 are not significantly removed by vacuum extraction. This technology addresses unsaturated soils only, which would be isolated by the cap (presumptive remedy) alone.	Would be very difficult to ensure appropriate implementation. Sufficient air flow through IWS 2 would likely not be achieved due to the permeability of soils and heterogeneous nature of the waste. Channeling would occur, and VOC may not be adequately removed from certain zones.	Low to Moderate Capital Moderate O&M	Retained due to: • Would provide reduction in toxicity, mobility, and volume through treatment.
Removal						
Excavation (IWS 2 only)	Mechanical Equipment	Excavation by mechanical means would provide for removal of material from IWS 2, prior to consolidation, treatment, or disposal. Excavation may be appropriate for areas with low to moderate volume (less than 100,000 cubic yards), where excavation will significantly reduce the risk posed by the overall site.	Excavation would limit continued migration of Contaminants of Concern into groundwater, as well as eliminate potential contact with Contaminants of Concern, although capping alone would achieve these objectives. There may be a high short-term risk of exposure to constituents during excavation activities. Also, since RI data indicate IWS 2 impacts on groundwater under current conditions is limited, excavation is not likely to significantly reduce the risk posed by the overall site.	Utilizes conventional technology. Would require compliance with a comprehensive health and safety program, dust control measures, and sediment runoff control. Would be some risk of mobilizing Contaminants of Concern during excavation and worsening the extent of subsurface contamination. If dewatering is required, high flow rates may need to be maintained, and groundwater extracted during dewatering would require appropriate treatment/disposal.	High Capital No O&M	Retained due to: • May be applicable to IWS 2 Area.

N/A - Not Applicable
*Cost relative to other process options within the same technology type.

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TABLE 2-3
SWDA, IWS 1, IWS 2, AND IWS 3
EVALUATION OF TECHNOLOGY PROCESS OPTIONS
PARKER LANDFILL PROJECT
LYNDONVILLE, VERMONT

Response Measure/Technology	Process Option	Description	Effectiveness	Implementability	Cost *	Status/Justification
Excavation (IWS 2 only) (cont)	Consolidation	Contaminated material excavated from IWS 2 would be consolidated and placed beneath the IWS 1 or 3 Area cap.	There would be minimal benefit associated with excavation and consolidation of IWS 2 materials, since a cap over IWS 2 alone would isolate the waste material, which is in the unsaturated zone. Contaminants of Concern have been detected at very low levels in some samples from saturated natural deposits below IWS 2; however, groundwater data do not indicate that IWS 2 is significantly impacting downgradient groundwater quality even under current conditions (without a cap). Therefore, removal of IWS 2 materials, even if this included materials from the saturated zone, is not expected to significantly reduce groundwater impacts. There would be no TMV reduction through treatment.	Excavation and handling of potentially hazardous material would be required. Would be a significant potential for worker and community exposure during implementation that would need to be addressed. If dewatering is necessary during excavation, high flow rates may need to be maintained, and groundwater extracted during dewatering would require appropriate treatment/disposal.	Moderate Capital Moderate O&M	Eliminated due to: • Limited benefits associated with implementation of this measure. • Significant potential for worker and community exposure during implementation. • Potential for significant implementability concerns associated with material dewatering.
Disposal of Excavated Materials (IWS 2 only)	Off-Site RCRA Facility	Excavated contaminated material which is determined to be a RCRA waste could be disposed of off-site at a RCRA facility.	Off-site disposal of excavated material prevents potential long-term contact at this location, but transfers potential exposure risks to another site. High worker safety, dust emissions, transportation, and traffic safety risks.	Contaminated materials may require treatment prior to disposal, based on land disposal requirements. Untreated off-site RCRA disposal does not reduce toxicity, mobility, or volume of waste.	High Capital No O&M	Eliminated due to: • High transportation and traffic and worker safety risks; • Simply transfers material from one facility to another; • High capital costs.
Ex-Situ Treatment (IWS material only)						
Incineration: Commercial Off-Site:	———	Incineration is used to destroy Contaminants of Concern. Incineration processes typically maintain soils at temperatures between 1,200°F and 2,000°F. Ash residue, typically considered a hazardous waste, is produced. The closest commercial incinerator to the Landfill that may accept the waste material for incineration is located in New Jersey. Depending on the requirements of the incineration facilities, transport as far as Texas may be required.	Incineration effectively reduces the PAH and VOC. Most metals would not be reduced, although a small fraction may volatize, requiring sophisticated air emissions control devices. Ash would contain residual metals and may be considered hazardous, requiring appropriate disposal.	Excavation of soil and solid waste is required. Hazardous material handling and long-distance transport would be required. Sorting and removal of large items may be required.	High Capital Low O&M	Retained due to: • Potential technology for disposal of excavated material from IWS 2 Area.

N/A - Not Applicable
*Cost relative to other process options within the same technology type.

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TABLE 2-4
GROUNDWATER
EVALUATION OF TECHNOLOGY PROCESS OPTIONS
PARKER LANDFILL PROJECT
LYNDONVILLE, VERMONT

Response Measure/Technology	Process Option	Description	Effectiveness	Implementability	Cost*	Status/Justification
No Action						
No Action	——	Natural degradation of organic contaminants would occur.	Degradation of organic contaminants would take place due to naturally occurring biodegradation and chemical decomposition.	Easily implemented.	N/A	Retained due to: • Provides basis for comparison with other options. • Required by the NCP.
Management						
Institutional Controls	Deed Restrictions Local Regulations	Restrictions placed on well installations and usage within the area that contains Contaminants of Concern which were released from the SWDA and/or IWS Areas and are found at concentrations above drinking-water standards.	Deed restrictions and local regulations regarding well water usage would effectively limit exposure to Contaminants of Concern in groundwater. Deed restrictions can be used to ensure connection to the municipal water supply system, which is currently available to all residences within the impacted area. A municipal water supply serves the residences north and west of the SWDA (including the trailer parks), the nursing home, and the housing development west of the SWDA. Municipal water is also available to homes along Red Village Road, from the intersection with Brown Road.	Easily implemented.	Low Capital No O&M	Retained due to: • Effective for regulating future groundwater use in the area of groundwater contamination.
Monitoring	——	Periodic monitoring of groundwater conditions conducted. Natural degradation of organic contaminants would occur.	Degradation of organic contaminants would take place due to naturally occurring biodegradation and chemical decomposition. Groundwater monitoring would chart the progress of natural degradation processes and effectiveness of remedial measures.	Easily implemented	Low Capital Low O&M	Retained due to: • Effectively tracks extent of Contaminants of Concern in the groundwater and associated naturally occurring degradation. • Allows the effectiveness of remedial measures to be monitored.

N/A - Not Applicable
*Cost relative to other process options within the same technology type.

TABLE 2-4
GROUNDWATER
EVALUATION OF TECHNOLOGY PROCESS OPTIONS
PARKER LANDFILL PROJECT
LYNDONVILLE, VERMONT

Response Measure/Technology	Process Option	Description	Effectiveness	Implementability	Cost*	Status/Justification
Withdrawal/Collection						
	Extraction Wells	Groundwater extraction wells are used to prevent further migration of Contaminants of Concern.	Extraction wells would prevent the SWDA and IWS Areas from acting as a source of Contaminants of Concern to groundwater downgradient of these areas.	Installation of extraction wells utilizes conventional well installation techniques. Experienced personnel are available. The need for installation of additional extraction wells would depend upon the results of hydraulic analyses evaluating the use of existing monitoring wells as extraction wells.	N/A	Retained due to: • Applicable and proven technology.
Ex-Situ Groundwater Treatment						
Organics Treatment	Granular Carbon Adsorption	Extracted groundwater would be pumped through a series of columns containing granular activated carbon (GAC). Organic constituents would be adsorbed from the aqueous-phase onto the surface of the GAC particles. The GAC would require periodic replacement or regeneration.	Carbon adsorption would effectively remove most of the organic constituents. Groundwater extracted from the vicinity of the SWDA or IWS Areas is likely to require metals pretreatment due to potential for metals, hardness and other organics to induce fouling, clogging and inhibition of the GAC treatment unit. Several organic constituents may not be effectively treated by carbon adsorption and may require other treatment, such as air stripping.	Carbon adsorption is commonly used to remove organic constituents from both wastewater and drinking water supplies. Due to potential for metals to adversely impact the GAC system, pretreatment to remove metals would be required. Aqueous-phase carbon adsorption systems are widely available.	Low to Moderate Capital; Low to Moderate O&M.	Air stripping with carbon adsorption polishing is retained as the representative process option train due to: • Applicable technology. • One or more process options may be selected to represent a technology type in order to simplify the subsequent development and evaluation of alternatives without limiting flexibility during remedial design.

N/A - Not Applicable
*Cost relative to other process options within the same technology type.

TABLE 2-4
GROUNDWATER
EVALUATION OF TECHNOLOGY PROCESS OPTIONS
PARKER LANDFILL PROJECT
LYNDONVILLE, VERMONT

Response Measure/Technology	Process Option	Description	Effectiveness	Implementability	Cost*	Status/Justification
Organics Treatment (cont'd)	Air Stripping	Extracted groundwater would be pumped through either a countercurrent packed tower aeration system or an induced draft air stripper. VOC would be transferred to the vapor phase. If off-gases exceed Vermont Department of Environmental Conservation (DEC) action levels for the Contaminants of Concern, off-gas treatment with vapor-phase activated carbon would be required.	Air stripping would effectively remove some of the organic Contaminants of Concern. Groundwater extracted from the vicinity of the SWDA or IWS Areas is likely to require metals pretreatment due to potential for metals to adversely impact organics treatment system. Effluent concentrations may not meet discharge requirements without further treatment, such as liquid phase carbon adsorption.	Air stripping is commonly employed to remove low level volatile organic constituents from groundwater. Air strippers are widely available. Air controls may be required if constituents in effluent gases exceed Vermont DEC action levels.	Low to Moderate Capital; Moderate to High O&M (Packed Tower); Low O&M (Induced Draft).	See Above
	Biological	Extracted groundwater would be pumped to above-ground bioreactors where microorganisms metabolize organic constituents into innocuous end products such as cellular material, carbon dioxide, and water. Adsorption and gravity settling assist in the removal process. Biological treatment may involve suspended-growth or fixed film systems. Both continuous-flow and batch-reactor treatment systems are available. Typical systems involve some variation of activated sludge process. Sludge generated as a by-product would require disposal.	Biological treatment would effectively remove some of the organic Contaminants of Concern. Groundwater extracted from the vicinity of the SWDA or IWS Areas is likely to require metals pretreatment since metals would adversely effect performance of biological treatment system. Polishing with activated carbon may be necessary to meet effluent discharge limitations. Nutrient addition may be required to sustain biological treatment activity.	Biological treatment in the form of fixed film towers or suspended growth systems are both available and commonly used to remove volatile organic constituents from water. Final carbon polishing units may be required.	Moderate Capital; Moderate to High O&M	
	Powdered Activated Carbon Treatment (PACT®)	PACT® is a hybrid technique combining several treatment mechanisms. Extracted groundwater would be treated in mixing tanks into which powdered activated carbon is added. Biological activity is promoted, in part as an attached-growth phenomenon, with the suspended carbon particles providing the attachment surface. Treatment occurs by a combination of air stripping, biological activities (both suspended and attached), adsorption, and settling.	PACT® is effective in removing and/or destroying a number of the organic Contaminants of Concern. The use of suspended carbon particles creates a substrate for the growth of longer-aged microbes than simple suspended growth systems, providing for longer effective biological treatment contact. However, PACT® is susceptible to toxic inhibition by high concentrations of metals such as those potentially present in the Study Area groundwater however, not to the extent as biological systems alone. Pretreatment to reduce metals may result in a stream low in organics.	PACT® is a proprietary system with both continuous-flow and sequencing-batch systems available. Mixing/aerating power and carbon are consumed. Settled sludge is generated. Systems have been installed on organic wastewaters.	Moderate to High Capital; Moderate to High O&M.	

N/A - Not Applicable
*Cost relative to other process options within the same technology type.

TABLE 2-4
GROUNDWATER
EVALUATION OF TECHNOLOGY PROCESS OPTIONS
PARKER LANDFILL PROJECT
LYNDONVILLE, VERMONT

Response Measure/Technology	Process Option	Description	Effectiveness	Implementability	Cost*	Status/Justification
Metals Treatment	Hydroxide/ Carbonate Precipitation	Lime or sodium hydroxide is used to remove metals from groundwater via pH adjustment, precipitation, flocculation, and settling. Filtering is often provided after settling.	Hydroxide/Carbonate precipitation is effective in removing most metals to the 100-200 ug/l range and may reduce organic contaminant concentrations. Dewatering and disposal of residual materials are required. Polishing treatment may be required after hydroxide/carbonate precipitation to meet target values.	Hydroxide/Carbonate precipitation uses readily available and proven technology.	Moderate Capital; Moderate O&M.	Hydroxide/Carbonate precipitation as the representative process option is retained due to: • Appropriate technology. • One process option may be selected to represent a technology type in order to simplify the subsequent development and evaluation of alternatives without limiting flexibility during remedial design. • Sulfide precipitation did not provide improved removal efficiencies during treatability testing.
	Sulfide Precipitation	Similar process to hydroxide carbonate precipitation, but very insoluble metal sulfides are precipitated out. The process involves pH adjustment and addition of soluble NaHS or insoluble FeS slurry.	Sulfide precipitation is effective in removing most metals from groundwater to <10 ug/l. Potentially hazardous metal sulfide sludge is formed, which requires dewatering and disposal. Treatability testing indicated that sulfide precipitation did not provide improved removal efficiencies versus the hydroxide/carbonate precipitation.	Sulfide precipitation uses readily available and proven technology. Treatability tests did not show substantial improvements in metals removal with sulfide treatment.	Moderate Capital; Moderate O&M.	
	Ion Exchange	Water is pumped through ion exchange vessels containing anionic or cationic resins selected to exchange specific dissolved metals, which are retained in the resin bed until the bed is exhausted. Vessels are periodically backwashed and regenerated with acid, base or salt solution.	Ion exchange is effective in removing metals from groundwater to the 10-50 ug/l range. Ion exchange media needs to be periodically backflushed and regenerated, resulting in a residual waste stream which requires dewatering and disposal. Multiple ion exchange vessels may be required to address different metals.	Ion exchange units are readily available and proven for removal of metals from groundwater. Operation is simple and relatively neat. Regeneration wastes are produced.	High Capital; Moderate O&M.	

N/A - Not Applicable
*Cost relative to other process options within the same technology type.

TABLE 2-4
GROUNDWATER
EVALUATION OF TECHNOLOGY PROCESS OPTIONS
PARKER LANDFILL PROJECT
LYNDONVILLE, VERMONT

Response Measure/Technology	Process Option	Description	Effectiveness	Implementability	Cost*	Status/Justification
Discharge of Extracted Groundwater						
Surface Water	Outfall pipelines to the Passumpsic River or Unnamed Stream	Groundwater would be discharged to the Passumpsic River or the Unnamed Stream, depending on the capacity of the receiving stream. Discharge to the Passumpsic River would require an outfall sewer pipeline from the Landfill.	Groundwater could be treated to meet discharge requirements. The assimilative capacity of the Passumpsic River is significantly greater than that of the Unnamed Stream. Surface water discharge requires obtaining an NPDES discharge permit and compliance with both concentration and toxicity effluent requirements. Based on the assimilative capacity of the Unnamed Stream, the NPDES requirements are likely to be extremely stringent. The technical ability to meet these standards is uncertain.	A surface discharge could be easily implemented and operated. For discharge to the Passumpsic River, an outfall pipeline would be required. This could be a gravity sewer with crossings of roads and railroad tracks, or a system under pressure.	Low to Moderate Capital; Low to Moderate O&M.	Discharge to the Passumpsic River is retained as the representative process option due to: • Appropriate technology. • The technical ability to meet effluent quality requirements for discharge to the Unnamed Stream is uncertain. • One process option may be selected to represent a technology type in order to simplify the subsequent development and evaluation of alternatives without limiting flexibility during remedial design.
Reinjection	——	Groundwater would be reinjected into the subsurface after treatment.	Introduction of treated groundwater into the subsurface may be difficult due to low permeability of soils. Appropriate permitting must the obtained.	Reinjection wells could be easily installed. Clogging may occur if water is not treated sufficiently.	Moderate to High Capital; Moderate O&M.	

N/A - Not Applicable
*Cost relative to other process options within the same technology type.

TABLE 4-1
ARARs SPECIFIC TO REMEDIAL ALTERNATIVE 1: NO-ACTION
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Chemical-Specific	Groundwater	Vermont Hazardous Waste Regulations (EPR 7-502)	Relevant and Appropriate	This regulation establishes the maximum permissible concentrations of hazardous constituents in groundwater in the uppermost aquifer underlying the waste management area beyond the point of compliance. An alternate concentration limit (ACL), based on protection of human health and the environment, may be established by the Regional Administrator.	• Maximum permissible concentrations for Contaminants of Concern that are currently exceeded will continue to be exceeded until or unless the source is depleted and/or natural degradation processes reduce their respective concentrations in groundwater below permissible levels. • Periodic groundwater monitoring would be required.
		Vermont Groundwater Protection Regulations (EPR 12)	Applicable	Water quality standards apply to regulatory programs that may affect groundwater resources. Primary Ground Water Quality Standards cover a broad range of chemicals that, if present, may detract from the intended use of the ground water. These standards include an "remediation goals" and a "preventive action limit," which is either 10% or 50% of the remediation goal. Both trigger a specified response. Secondary Ground Water Quality Standards covering parameters that affect aesthetic qualities, also include a preventive action limit, which is 50% of the remediation goal.	• Remediation goals for Contaminants of Concern that are currently exceeded will continue to be exceeded until or unless the source is depleted and/or natural degradation processes reduce their respective concentrations in groundwater below these standards.
		Federal Safe Drinking Water Maximum Contaminant Levels (MCLs) for organic and inorganic chemicals (40 CFR 141 Subparts B, G, and I).	Relevant and Appropriate	MCLs have been promulgated for a number of common organic and inorganic contaminants; and action levels have been promulgated for lead and copper. These levels regulate the concentration of contaminants in public drinking water supplies, but may also be considered appropriate for groundwater aquifers potentially used for drinking water.	• MCLs for Contaminants of Concern that are currently exceeded will continue to be exceeded until or unless the source is depleted and/or natural degradation processes reduce their respective concentrations in groundwater below the MCLs.

TABLE 4-1
ARARs SPECIFIC TO REMEDIAL ALTERNATIVE 1: NO-ACTION
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Chemical-Specific (cont'd)	Groundwater (cont'd)	Federal Safe Drinking Water Maximum Contaminant Level Goals (MCLGs) for organic and inorganic chemicals (40 CFR 141 Subpart F).	Relevant and Appropriate	MCLGs are health-based goals (non-enforceable) for public water supplies. MCLGs are levels considered to have no known or anticipated negative health effects which includes a margin of safety. These goals are available for a number of organic and inorganic contaminants.	• MCLGs that are currently exceeded will continue to be exceeded until or unless the source is depleted and/or natural degradation processes reduce the concentrations of contaminants below the MCLGs.
		Federal Safe Drinking Water National Secondary Maximum Contaminant Levels (SMCLs) (40 CFR 143.3).	To Be Considered	These regulations control contaminants that affect the aesthetic qualities of drinking water such as appearance, odor and taste. SMCLs are not federally enforceable but are intended to be used by states as guidelines.	• To be considered in selecting remedial alternative.
		Federal Safe Drinking Water proposed MCLs for synthetic organic chemicals and inorganic chemicals (40 CFR 141).	To Be Considered	These regulations would establish MCLs for certain chemical species.	• To be considered in selecting remedial alternative.
		Federal Drinking Water Health Advisories.	To Be Considered	EPA publishes contaminant-specific health advisories that indicate the non-carcinogenic risks associated with consuming contaminated drinking water.	• To be considered in selecting remedial alternative.
		Federal Groundwater Protection Strategy (EPA, August 1984).	To Be Considered	EPA's GPS includes a component which states that groundwater is ecologically vital, if the aquifer provides the base flow for a particularly sensitive ecosystem which, if polluted, would destroy a unique habitat.	• To be considered in selecting remedial alternative. • The aquifer below the Study Area does not provide the base flow for a sensitive habitat.

TABLE 4-1
ARARs SPECIFIC TO REMEDIAL ALTERNATIVE 1: NO-ACTION
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Chemical-Specific (cont'd)	Sediment	Federal Interim Sediment Quality Criteria	To Be Considered	Sediment quality criteria were compiled from studies of effects of toxic compounds in sediments on benthic biota. Sediment quality criteria have been published for metals, PAHs, and other persistent organic compounds.	• To be considered in selecting remedial alternative. • Sediment quality criteria for Contaminants of Concern that are currently exceeded will continue to be exceeded until or unless the source is depleted and/or natural degradation processes reduce their respective concentrations in sediment below the recommended criteria.
Action-Specific	N/A	Vermont Hazardous Waste Regulations (EPR Chapter 7 Subchapter 5)	Applicable	These regulations establish requirements for hazardous waste facilities, including facility standards, emergency preparedness and prevention, and contingency planning. Closure of land disposal units shall be implemented to accomplish the objectives detailed in 40 CFR 264 Subpart F (Releases from waste management units), Subpart G (Closure and post-closure), and Subpart N (Landfills).	• The No Action Alternative does not fully satisfy security requirements, nor does it accomplish the specified objectives of closure and post-closure care for IWS Areas.
		Vermont Solid Waste Regulations (EPR Section 6-702)	Applicable	Final cover on solid waste landfills are required to have a minimum slope of 5 percent and a maximum slope of 33⅓ percent. Grass or ground cover must be established within four months of final cover, or as soon as weather permits.	• The No Action Alternative meets these requirements for the SWDA.

TABLE 4-1
ARARs SPECIFIC TO REMEDIAL ALTERNATIVE 1: NO-ACTION
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Action-Specific (cont'd)	N/A	Federal Solid Waste Regulations (40 CFR 258.60)	To Be Considered	The final cover system installed on a solid waste landfill must be designed to minimize infiltration and erosion, and consist of an infiltration layer underlying an erosion layer. The infiltration layer must have at least 18" of earthen material that has a low permeability. The erosion layer must consist of at least 6" of earthen material that is capable of sustaining native plant growth.	• Vermont solid waste cover requirements are more stringent.
		Vermont Land Use and Development Law (Act 250 - 10 VSA Chapter 151)	Relevant and Appropriate	Construction of improvements on tracts of land larger than 10 acres are required to comply with criteria specified in the Act, including no undue air or water pollution, no disposal of harmful or toxic substances to groundwater, no unreasonable soil erosion, compliance with wetlands rules, and no adverse affects on aesthetic values.	• The No Action Alternative does not facilitate compliance with the groundwater protection aspect of the Act.
	Surface Waters	Vermont Water Quality Standards (EPR Section 2-05))	Applicable	Stormwater runoff shall not have an undue adverse effect on the receiving waters.	• The No Action Alternative does not facilitate compliance with the prohibition on undue adverse effects of stormwater on receiving waters.
Location-Specific	Floodplains and Seismic Zones	Vermont Hazardous Waste Regulations (EPR 7-502)	Relevant and Appropriate	Hazardous waste disposal facilities are not to be located in seismically active areas nor in 100-year floodplains (unless washout can be prevented or no adverse effects of washout can be substantiated).	• IWS Areas are not located in a seismically active area or in a 100-year floodplain.
	Groundwater, Wetlands, and Floodplains	Vermont Solid Waste Regulations (EPR 6-502, 503)	Relevant and Appropriate	Solid waste disposal facilities are not to be located in Class I or Class II groundwater areas, significant wetlands, or a 100-year floodplain/flood stage elevation. Solid waste facilities are to be located so as not to adversely affect drinking water supplies.	• The SWDA is not located in the sensitive areas outlined.

TABLE 4-2
ARARs SPECIFIC TO REMEDIAL ALTERNATIVE 2:
CONTAINMENT (SWDA, IWS 1, 2, and 3)/NO SOURCE CONTROL GROUNDWATER
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Chemical-Specific	Air	Vermont Air Pollution Control Regulations (EPR Chapter 5)	Relevant and Appropriate	The following provisions of Vermont air emissions regulations address relevant and appropriate air pollution issues: controlling emissions of conventional pollutants and hazardous air pollutants to prevent ambient concentrations from exceeding NAAQS and Hazard Limiting Values, respectively; minimizing fugitive particulate emissions from material handling and construction; and controlling nuisances and odors.	• Gas collection system for the IWS Areas will be evaluated to determine if pollution thresholds are exceeded for control technology application.
		Federal NESHAP for Vinyl Chloride (40 CFR 61 Subpart F)	Relevant and Appropriate	Specifies that the concentration of vinyl chloride in exhaust gas from control equipment must not exceed 10 ppm.	• Gas collection system for the IWS Areas will be evaluated to determine if vinyl chloride thresholds are exceeded for control technology application.
		Federal NESHAP for Benzene Waste Operations (40 CFR 61 Subpart FF)	Relevant and Appropriate	Specifies that benzene waste treatment processes either: (1) removes benzene from the waste stream to a level less than 10 ppm, or (2) removes benzene from the waste stream by 99 percent or more on a mass basis, or (3) incinerates the benzene in a combustion unit that achieves a 99 percent destruction efficiency.	• Gas collection system for the IWS Areas will be evaluated to determine if benzene thresholds are exceeded for control technology application.
	Groundwater	Vermont Hazardous Waste Regulations (EPR 7-502)	Relevant and Appropriate	This regulation establishes the maximum permissible concentrations of hazardous constituents in groundwater in the uppermost aquifer underlying the waste management area beyond the point of compliance. An alternate concentration limit (ACL), based on protection of human health and the environment, may be established by the Regional Administrator.	• Groundwater quality would improve due to presence of caps on SWDA and IWS Areas; however, maximum permissible concentrations for Contaminants of Concern that are currently exceeded will continue to be exceeded until or unless the source is depleted and/or natural degradation processes reduce their respective concentrations in groundwater below permissible levels.

TABLE 4-2
ARARs SPECIFIC TO REMEDIAL ALTERNATIVE 2:
CONTAINMENT (SWDA, IWS 1, 2, and 3)/NO SOURCE CONTROL GROUNDWATER
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Chemical-Specific (cont'd)	Groundwater (cont'd)	Vermont Groundwater Protection Regulations (EPR 12)	Applicable	Water quality standards apply to regulatory programs that may affect groundwater resources. Primary Ground Water Quality Standards cover a broad range of chemicals that, if present, may detract from the intended use of the ground water. These standards include an "remediation goal", based on federal MCLs, USEPA Office of Drinking Water, Lifetime Health Advisory, or a Vermont Health Advisory, and a "preventive action limit", which is either 10% or 50% of the remediation goal. Both trigger a specified response. Secondary Ground Water Quality Standards covering parameters that affect aesthetic qualities, also include a preventive action limit, which is 50% of the remediation goal.	• Groundwater quality would improve due to presence of caps on SWDA and IWS Areas; however, remediation goals for Contaminants of Concern that are currently exceeded will continue to be exceeded until or unless the source is depleted and/or natural degradation processes reduce their respective concentrations in groundwater below these standards.
		Federal Safe Drinking Water Maximum Contaminant Levels (MCLs) for organic and inorganic chemicals (40 CFR 141 Subparts B, G, and I)	Relevant and Appropriate	MCLs have been promulgated for a number of common organic and inorganic contaminants; and action levels have been promulgated for lead and copper. These levels regulate the concentration of contaminants in public drinking water supplies, but may also be considered appropriate for groundwater aquifers potentially used for drinking water.	• Groundwater quality would improve due to presence of caps on SWDA and IWS Areas; however, MCLs for Contaminants of Concern that are currently exceeded will continue to be exceeded until or unless the source is depleted and/or natural degradation processes reduce their respective concentrations in groundwater below the MCLs.

TABLE 4-2
ARARs SPECIFIC TO REMEDIAL ALTERNATIVE 2:
CONTAINMENT (SWDA, IWS 1, 2, and 3)/NO SOURCE CONTROL GROUNDWATER
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Chemical-Specific (cont'd)	Groundwater (cont'd)	Federal Safe Drinking Water Maximum Contaminant Level Goals (MCLGs) for organic and inorganic chemicals (40 CFR 141 Subpart F)	Relevant and Appropriate	MCLGs are health-based goals (non-enforceable) for public water supplies. MCLGs are levels considered to have no known or anticipated negative health effects which includes a margin of safety. These goals are available for a number of organic and inorganic contaminants.	• Groundwater quality would improve due to presence of caps on SWDA and IWS Areas; however, MCLGs that are currently exceeded will continue to be exceeded until or unless the source is depleted and/or natural degradation processes reduce the concentrations of contaminants below the MCLGs.
		Federal Safe Drinking Water National Secondary Maximum Contaminant Levels (SMCLs) (40 CFR 143.3)	To Be Considered	These regulations control contaminants that affect the aesthetic qualities of drinking water such as appearance, odor, and taste. SMCLs are not federally enforceable but are intended to be used by states as guidelines.	• To be considered in selecting remedial alternative.
		Federal Safe Drinking Water proposed MCLs for synthetic organic chemicals and inorganic chemicals (40 CFR 141)	To Be Considered	These regulations would establish MCLs for certain chemical species.	• To be considered in selecting remedial alternative.
		Federal Drinking Water Health Advisories	To Be Considered	EPA publishes contaminant-specific health advisories that indicate the non-carcinogenic risks associated with consuming contaminated drinking water.	• To be considered in selecting remedial alternative.
		Federal Groundwater Protection Strategy (EPA, August 1984)	To Be Considered	EPA's GPS includes a component which states that groundwater is ecologically vital, if the aquifer provides the base flow for a particularly sensitive ecosystem which, if polluted, would destroy a unique habitat.	• To be considered in selecting remedial alternative. • The aquifer below the Study Area does not provide the base flow for a sensitive habitat.

TABLE 4-2
ARARs SPECIFIC TO REMEDIAL ALTERNATIVE 2:
CONTAINMENT (SWDA, IWS 1, 2, and 3)/NO SOURCE CONTROL GROUNDWATER
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Chemical-Specific (cont'd)	Sediment	Federal Interim Sediment Quality Criteria	To Be Considered	Sediment quality criteria were compiled from studies of effects of toxic compounds in sediments on benthic biota. Sediment quality criteria have been published for metals, PAHs, and other persistent organic compounds.	• To be considered in selecting remedial alternative. • Sediment quality would improve due to presence of cap on SWDA and IWS Areas; however, sediment quality criteria for Contaminants of Concern that are currently exceeded will continue to be exceeded until or unless the source is depleted and/or natural degradation processes reduce their respective concentrations in sediment below the recommended criteria.
Action-Specific	N/A	Vermont Hazardous Waste Regulations (EPR Chapter 7 Subchapter 5)	Applicable	These regulations establish requirements for hazardous waste facilities, including facility standards, emergency preparedness and prevention, and contingency planning. Closure of land disposal units shall be implemented to accomplish the objectives detailed in 40 CFR 264 Subpart F (Releases from waste management units), Subpart G (Closure and post-closure), and Subpart N (Landfills).	• Alternative 2 will satisfy security requirements and accomplish the specified objectives of closure and post-closure care that are applicable to IWS Areas.
		Vermont Solid Waste Regulations (EPR Section 6-702)	Applicable	Final cover on solid waste landfills are required to have a minimum slope of 5 percent and a maximum slope of 33⅓ percent. Grass or ground cover must be established within four months of final cover, or as soon as weather permits.	• Alternative 2 will satisfy the final cover requirements applicable to the SWDA.

TABLE 4-2
ARARs SPECIFIC TO REMEDIAL ALTERNATIVE 2:
CONTAINMENT (SWDA, IWS 1, 2, and 3)/NO SOURCE CONTROL GROUNDWATER
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Action-Specific (cont'd)	N/A	Federal Solid Waste Regulations (40 CFR 258.60)	To Be Considered	The final cover system installed on a solid waste landfill must be designed to minimize infiltration and erosion, and consist of an infiltration layer underlying an erosion layer. The infiltration layer must have at least 18" of earthen material that has a low permeability. The erosion layer must consist of at least 6" of earthen material that is capable of sustaining native plant growth.	• Vermont solid waste cover requirements are more stringent.
		EPA Technical Guidance Document: Final Covers on Hazardous Waste Landfills and Surface Impoundments	To Be Considered	Presents EPA recommendations on design specifications for multilayer landfill caps.	• To be considered in designing a cap for IWS Areas.
		Federal Noise Control Regulations (40 CFR 204, 205)	Applicable	Establish noise emission standards applicable to portable air compressors and medium and heavy duty trucks.	• Construction equipment will be required to comply with applicable noise emission standards.
		Vermont Land Use and Development Law (Act 250 - 10 VSA Chapter 151)	Relevant and Appropriate	Construction of improvements on tracts of land larger than 10 acres are required to comply with criteria specified in the Act, including no undue air or water pollution, no disposal of harmful or toxic substances to groundwater, no unreasonable soil erosion, compliance with wetlands rules, and no adverse affects on aesthetic values.	• Alternative 2 facilitates compliance with the Act by reducing leachate generation and controlling erosion from SWDA and IWS Areas.
	Air	Federal Proposed Regulation for Control of VOCs	To Be Considered	Proposes emission standards for VOCs from groundwater treatment units such as air strippers.	• To be considered in predesign studies.
	Surface Waters	Vermont Water Quality Standards (EPR Section 2-05))	Applicable	Stormwater runoff shall not have an undue adverse effect on the receiving waters.	• Alternative 2 will facilitate compliance with this requirement by controlling erosion and runoff from SWDA and IWS Areas.

TABLE 4-2
ARARs SPECIFIC TO REMEDIAL ALTERNATIVE 2:
CONTAINMENT (SWDA, IWS 1, 2, and 3)/NO SOURCE CONTROL GROUNDWATER
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Location-Specific	Floodplains and Seismic Zones	Vermont Hazardous Waste Regulations (EPR 7-502)	Relevant and Appropriate	Hazardous waste disposal facilities are not to be located in seismically active areas nor in 100-year floodplains (unless washout can be prevented or no adverse effects of washout can be substantiated).	• IWS Areas are not located in a seismically active area or in a 100-year floodplain.
	Groundwater, Wetlands, and Floodplains	Vermont Solid Waste Regulations (EPR 6-502, 503)	Relevant and Appropriate	Solid waste disposal facilities are not to be located in Class I or Class II groundwater areas, significant wetlands, or a 100-year floodplain/flood stage elevation. Solid waste facilities are to be located so as not to adversely affect drinking water supplies.	• The SWDA is not located in the sensitive areas outlined.
	Wetlands	Vermont Wetland Rules	Applicable	These regulations include procedures for the identification, classification, and protection of wetlands.	• Alternative 2 improves protection of significant wetlands.
		Federal Guidelines for Specification of Disposal Sites for Dredged or Fill Material (40 CFR 230)	Relevant and Appropriate	A proposed disposal site for the discharge of dredged or fill material is determined to be either in compliance or non-compliance with the guidelines given here. These guidelines cover potential impacts on human use characteristics and potential impacts on aquatic ecosystems including: physical and chemical characteristics, biological characteristics, and special aquatic sites. The regulations also specify evaluation and testing to make determinations, and actions to minimize adverse effects.	• Alternative 2 minimizes adverse effects to wetlands in the Study Area.
		Federal Fish and Wildlife Coordination Regulations (50 CFR 297)	Applicable	Establishes requirements for a consultation with U.S. Fish and Wildlife Service and state wildlife agencies to mitigate losses of fish and wildlife that result from modification of waters.	• Alternative 2 meets this requirement.

TABLE 4-2
ARARs SPECIFIC TO REMEDIAL ALTERNATIVE 2:
CONTAINMENT (SWDA, IWS 1, 2, and 3)/NO SOURCE CONTROL GROUNDWATER
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Location-Specific (cont'd)	Wetlands (cont'd)	Federal Army Corps of Engineers Nationwide Permit Program Regulations (33 CFR 330, Appendix A)	Relevant and Appropriate	Lists conditions that must be met for the nationwide general permit to discharge dredged or fill material. These conditions include consideration of maintenance, erosion and siltation controls, aquatic life movements, equipment usage, endangered species, suitable material, and mitigation.	• Substantive conditions for a general permit will be met under this alternative.
		Federal Executive Order 11990 Protection of Wetlands (40 CFR 6, Appendix A)	Applicable	Directs federal agencies to avoid, where possible, adversely effecting or destroying wetlands. Requirements for wetlands determination, assessment, and preservation or restoration are set forth.	• To be considered in predesign studies.

TABLE 4-3
ARARs SPECIFIC TO REMEDIAL ALTERNATIVES 3, 5, and 8B[1]
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Chemical-Specific	Air	Vermont Air Pollution Control Regulations (EPR Chapter 5)	Relevant and Appropriate	The following provisions of Vermont air emissions regulations address relevant and appropriate air pollution issues: controlling emissions of conventional pollutants and hazardous air pollutants to prevent ambient concentrations from exceeding NAAQS and Hazard Limiting Values, respectively; minimizing fugitive particulate emissions from material handling and construction; and controlling nuisances and odors.	• Gas collection system for the IWS Areas will be evaluated to determine if pollution thresholds are exceeded for control technology application.
		Federal NESHAP for Vinyl Chloride (40 CFR 61 Subpart F)	Relevant and Appropriate	Specifies that the concentration of vinyl chloride in exhaust gas from control equipment must not exceed 10 ppm.	• Gas collection system for the IWS Areas will be evaluated to determine if vinyl chloride thresholds are exceeded for control technology application.
		Federal NESHAP for Benzene Waste Operations (40 CFR 61 Subpart FF)	Relevant and Appropriate	Specifies that benzene waste treatment processes either: (1) removes benzene from the waste stream to a level less than 10 ppm, or (2) removes benzene from the waste stream by 99 percent or more on a mass basis, or (3) incinerates the benzene in a combustion unit that achieves a 99 percent destruction efficiency.	• Gas collection system for the IWS Areas will be evaluated to determine if benzene thresholds are exceeded for control technology application.

[1] Alternative 3: Containment (SWDA, IWS 1, 2, and 3)/Source Control Groundwater;
Alternative 5: Containment (SWDA, IWS 1, 2, and 3)/In-Situ Soil Vapor Extraction of IWS2 /Source Control Groundwater;
Alternative 8B: Downgradient Groundwater Extraction/Treatment/Discharge/Combined with Alternative 3 or 5.

TABLE 4-3
ARARs SPECIFIC TO REMEDIAL ALTERNATIVES 3, 5, and 8B:
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Chemical-Specific (cont'd)	Groundwater	Vermont Hazardous Waste Regulations (EPR 7-502)	Relevant and Appropriate	This regulation establishes the maximum permissible concentrations of hazardous constituents in groundwater in the uppermost aquifer underlying the waste management area beyond the point of compliance. An alternate concentration limit (ACL), based on protection of human health and the environment, may be established by the Regional Administrator.	• Groundwater quality would improve due to presence of caps on SWDA and IWS Areas; however, maximum permissible concentrations for Contaminants of Concern that are currently exceeded will continue to be exceeded until or unless the source is depleted and/or natural degradation processes reduce their respective concentrations in groundwater below permissible levels.
		Vermont Groundwater Protection Regulations (EPR 12)	Applicable	Water quality standards apply to regulatory programs that may affect groundwater resources. Primary Ground Water Quality Standards cover a broad range of chemicals that, if present, may detract from the intended use of the ground water. These standards include an "remediation goal", based on federal MCLs, USEPA Office of Drinking Water, Lifetime Health Advisory, or a Vermont Health Advisory, and a "preventive action limit", which is either 10% or 50% of the remediation goal. Both trigger a specified response. Secondary Ground Water Quality Standards covering parameters that affect aesthetic qualities, also include a preventive action limit, which is 50% of the remediation goal.	• Groundwater quality would improve due to presence of caps on SWDA and IWS Areas. • Groundwater quality within the capture zone of the source control extraction system is not expected to achieve compliance with remediation goals until the source is depleted and/or natural degradation processes reduce their respective concentrations in groundwater below these standards. • Groundwater quality downgradient of the capture zone of the source control extraction system would meet remediation goals after some period of treatment system operation.

TABLE 4-3
ARARs SPECIFIC TO REMEDIAL ALTERNATIVES 3, 5, and 8B:
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Chemical-Specific (cont'd)	Groundwater (cont'd)	Federal Safe Drinking Water Maximum Contaminant Levels (MCLs) for organic and inorganic chemicals (40 CFR 141 Subparts B, G, and I)	Relevant and Appropriate	MCLs have been promulgated for a number of common organic and inorganic contaminants; and action levels have been promulgated for lead and copper. These levels regulate the concentration of contaminants in public drinking water supplies, but may also be considered appropriate for groundwater aquifers potentially used for drinking water.	• Groundwater quality would improve due to presence of caps on SWDA and IWS Areas. • Groundwater quality within the capture zone of the source control extraction system is not expected to achieve compliance with remediation goals until the source is depleted and/or natural degradation processes reduce their respective concentrations in groundwater below these standards. • Groundwater quality downgradient of the capture zone of the source control extraction system would meet MCLs after some period of treatment system operation.

TABLE 4-3
ARARs SPECIFIC TO REMEDIAL ALTERNATIVES 3, 5, and 8B:
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Chemical-Specific (cont'd)	Groundwater (cont'd)	Federal Safe Drinking Water Maximum Contaminant Level Goals (MCLGs) for organic and inorganic chemicals (40 CFR 141 Subpart F)	Relevant and Appropriate	MCLGs are health-based goals (non-enforceable) for public water supplies. MCLGs are levels considered to have no known or anticipated negative health effects which includes a margin of safety. These goals are available for a number of organic and inorganic contaminants.	• Groundwater quality would improve due to presence of caps on SWDA and IWS Areas. • Groundwater quality within the capture zone of the source control extraction system is not expected to achieve compliance with remediation goals until the source is depleted and/or natural degradation processes reduce their respective concentrations in groundwater below these standards. • Groundwater quality downgradient of the capture zone of the source control extraction system would meet MCLGs after some period of treatment system operation.
		Federal Safe Drinking Water National Secondary Maximum Contaminant Levels (SMCLs) (40 CFR 143.3)	To Be Considered	These regulations control contaminants that affect the aesthetic qualities of drinking water such as appearance, odor, and taste. SMCLs are not federally enforceable but are intended to be used by states as guidelines.	• To be considered in selecting remedial alternative.
		Federal Safe Drinking Water proposed MCLs for synthetic organic chemicals and inorganic chemicals (40 CFR 141)	To Be Considered	These regulations would establish MCLs for certain chemical species.	• To be considered in selecting remedial alternative.
		Federal Drinking Water Health Advisories	To Be Considered	EPA publishes contaminant-specific health advisories that indicate the non-carcinogenic risks associated with consuming contaminated drinking water.	• To be considered in selecting remedial alternative.

TABLE 4-3
ARARs SPECIFIC TO REMEDIAL ALTERNATIVES 3, 5, and 8B:
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Chemical-Specific (cont'd)	Groundwater (cont'd)	Federal Groundwater Protection Strategy (EPA, August 1984)	To Be Considered	EPA's GPS includes a component which states that groundwater is ecologically vital, if the aquifer provides the base flow for a particularly sensitive ecosystem which, if polluted, would destroy a unique habitat.	• To be considered in selecting remedial alternative. • The aquifer below the Study Area does not provide the base flow for a sensitive habitat.
	Sediment	Federal Interim Sediment Quality Criteria	To Be Considered	Sediment quality criteria were compiled from studies of effects of toxic compounds in sediments on benthic biota. Sediment quality criteria have been published for metals, PAHs, and other persistent organic compounds.	• To be considered in selecting remedial alternative. • Sediment quality would improve due to presence of cap on SWDA and IWS Areas.
Action-Specific	N/A	Vermont Hazardous Waste Regulations (EPR Chapter 7 Subchapter 3)	Applicable	Hazardous waste that is generated from remedial activities and requires off-site disposal will need to be managed in accordance with generator requirements, including identification of waste, accumulation in containers or tanks, marking and labelling, and manifesting the waste to its final destination.	• Hazardous wastes generated during remedial activities will be managed in accordance with generator requirements.
		Vermont Hazardous Waste Regulations (EPR Chapter 7 Section 7-106)	Applicable	Hazardous waste that is manifested off-site will require notification to the TSDF that the waste is a restricted waste and either meets or does not meet LDR treatment standards.	• Hazardous wastes shipped off-site will be accompanied by LDR notification to the TSDF.

TABLE 4-3
ARARs SPECIFIC TO REMEDIAL ALTERNATIVES 3, 5, and 8B:
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Action-Specific	N/A	Vermont Hazardous Waste Regulations (EPR Chapter 7 Subchapter 5)	Applicable	These regulations establish requirements for hazardous waste facilities, including facility standards, emergency preparedness and prevention, and contingency planning. Closure of land disposal units shall be implemented to accomplish the objectives detailed in 40 CFR 264 Subpart F (Releases from waste management units), Subpart G (Closure and post-closure), and Subpart N (Landfills).	• Alternative 3, 5 or 8B will satisfy security requirements and accomplish the specified objectives of closure and post-closure care that are applicable to IWS Areas.
		Vermont Solid Waste Regulations (EPR Section 6-702)	Applicable	Final cover on solid waste landfills are required to have a minimum slope of 5 percent and a maximum slope of 33⅓ percent. Grass or ground cover must be established within four months of final cover, or as soon as weather permits.	• Alternative 3, 5 or 8B will satisfy the final cover requirements applicable to the SWDA.
		Federal Solid Waste Regulations (40 CFR 258.60)	To Be Considered	The final cover system installed on a solid waste landfill must be designed to minimize infiltration and erosion, and consist of an infiltration layer underlying an erosion layer. The infiltration layer must have at least 18" of earthen material that has a low permeability. The erosion layer must consist of at least 6" of earthen material that is capable of sustaining native plant growth.	• Vermont solid waste cover requirements are more stringent.
		EPA Technical Guidance Document: Final Covers on Hazardous Waste Landfills and Surface Impoundments	To Be Considered	Presents EPA recommendations on design specifications for multilayer landfill caps.	• To be considered in designing a cap for IWS Areas.
		Federal Noise Control Regulations (40 CFR 204, 205)	Applicable	Establish noise emission standards applicable to portable air compressors and medium and heavy duty trucks.	• Construction equipment will be required to comply with applicable noise emission standards.

TABLE 4-3
ARARs SPECIFIC TO REMEDIAL ALTERNATIVES 3, 5, and 8B:
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Action-Specific (cont'd)	N/A	Vermont Land Use and Development Law (Act 250 - 10 VSA Chapter 151)	Relevant and Appropriate	Construction of improvements on tracts of land larger than 10 acres are required to comply with criteria specified in the Act, including no undue air or water pollution, no disposal of harmful or toxic substances to groundwater, no unreasonable soil erosion, compliance with wetlands rules, and no adverse affects on aesthetic values.	• Alternative 3, 5 or 8B facilitates compliance with the Act by reducing leachate generation and controlling erosion from SWDA and IWS Areas.
	Air	Federal Proposed Regulation for Control of VOCs	To Be Considered	Proposes emission standards for VOCs from groundwater treatment units such as air strippers.	• To be considered in predesign studies.
	Surface Waters	Vermont Water Quality Standards (EPR Section 1-04)	Applicable	Outlines criteria for discharging into waters of the state and discusses the assimilative capacity of such waters.	• Alternative 3, 5 or 8B meets these criteria.
		Vermont Water Quality Standards (EPR Section 2-02)	Applicable	Water quality criteria are to be calculated on the basis of 7Q10 flow values.	• Alternative 3, 5 or 8B satisfies this requirement.
		Vermont Water Quality Standards (EPR Section 2-03)	Applicable	A specific portion of the receiving waters that does not exceed 200 feet from the point of discharge shall be the designated mixing zone for properly treated waste. The mixing zone shall not have adverse effects on human health, aquatic life, or existing uses of the receiving waters.	• Alternative 3, 5 or 8B satisfies these requirement.
		Vermont Water Quality Standards (EPR Section 2-05))	Applicable	Stormwater runoff shall not have an undue adverse effect on the receiving waters.	• Alternative 3, 5 or 8B will facilitate compliance with this requirement by controlling erosion and runoff from SWDA and IWS Areas.
		Vermont Water Quality Standards (EPR Section 3-01)	Applicable	Outlines the established criteria for dissolved oxygen, temperature, phosphorus, nitrates, aquatic habitats, sludge deposits or solid refuse, solids and oil, alkalinity, pH, and toxic substances, except in mixing zones.	• Alternative 3, 5 or 8B meets these criteria.

TABLE 4-3
ARARs SPECIFIC TO REMEDIAL ALTERNATIVES 3, 5, and 8B:
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Action-Specific (cont'd)	Surface Waters (cont'd)	Vermont Water Quality Standards (EPR Section 3-04)	Applicable	Outlines the criteria for turbidity, *E. coli*, color, taste, and odor, except in mixing zones.	• Alternative 3, 5 or 8B meets these criteria.
		Vermont Water Quality Standards (EPR Section 3-06)	Applicable	Toxic wastes concentrations shall not have an adverse impact on human health, or aquatic life.	• Alternative 3, 5 or 8B meets these criteria.
		Vermont Water Quality Standards (EPR Appendix D)	Applicable	Outlines current water quality criteria for the protection of aquatic biota.	• Alternative 3, 5 or 8B meets these criteria.
		Vermont NPDES Permit Program Regulations (EPR Chapter 13)	Relevant and appropriate	Specify the procedures required to obtain a NPDES permit to discharge any waste into the waters of Vermont, and the terms and conditions of permits. Requirements for monitoring, recording, and reporting are also included.	• Alternative 3, 5 or 8B satisfies these requirements.
		Federal Quality Criteria for Water	Applicable	Pursuant to Section 304(a)(1) of the Clean Water Act, the EPA establishes ambient water quality criteria. These criteria present scientific data and guidance on the environmental effects of pollutants. The criteria can contribute to establishing regulatory requirements that govern impacts to water quality.	• Alternative 3, 5 or 8B meets these criteria.
Location-Specific	Floodplains and Seismic Zones	Vermont Hazardous Waste Regulations (EPR 7-502)	Relevant and Appropriate	Hazardous waste disposal facilities are not to be located in seismically active areas nor in 100-year floodplains (unless washout can be prevented or no adverse effects of washout can be substantiated).	• IWS Areas are not located in a seismically active area or in a 100-year floodplain.

TABLE 4-3
ARARs SPECIFIC TO REMEDIAL ALTERNATIVES 3, 5, and 8B:
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Location-Specific	Groundwater, Wetlands, and Floodplains	Vermont Solid Waste Regulations (EPR 6-502, 503)	Relevant and Appropriate	Solid waste disposal facilities are not to be located in Class I or Class II groundwater areas, significant wetlands, or a 100-year floodplain/flood stage elevation. Solid waste facilities are to be located so as not to adversely affect drinking water supplies.	• The SWDA is not located in the sensitive areas outlined.
	Wetlands	Vermont Wetland Rules	Applicable	These regulations include procedures for the identification, classification, and protection of wetlands.	• Alternative 3, 5 or 8B improves protection of significant wetlands.
		Federal Guidelines for Specification of Disposal Sites for Dredged or Fill Material (40 CFR 230)	Relevant and Appropriate	A proposed disposal site for the discharge of dredged or fill material is determined to be either in compliance or non-compliance with the guidelines given here. These guidelines cover potential impacts on human use characteristics and potential impacts on aquatic ecosystems including: physical and chemical characteristics, biological characteristics, and special aquatic sites. The regulations also specify evaluation and testing to make determinations, and actions to minimize adverse effects.	• Alternative 3, 5 or 8B minimizes adverse effects to wetlands in the Study Area.
		Federal Fish and Wildlife Coordination Regulations (50 CFR 297)	Applicable	Establishes requirements for a consultation with U.S. Fish and Wildlife Service and state wildlife agencies to mitigate losses of fish and wildlife that result from modification of waters.	• Alternative 3, 5 or 8B meets this requirement.
		Federal Army Corps of Engineers Nationwide Permit Program Regulations (33 CFR 330, Appendix A)	Relevant and Appropriate	Lists conditions that must be met for the nationwide general permit to discharge dredged or fill material. These conditions include consideration of maintenance, erosion and siltation controls, aquatic life movements, equipment usage, endangered species, suitable material, and mitigation.	• Substantive conditions for a general permit will be met.

TABLE 4-3
ARARs SPECIFIC TO REMEDIAL ALTERNATIVES 3, 5, and 8B:
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Location-Specific (cont'd)	Wetlands (cont'd)	Federal Executive Order 11990 Protection of Wetlands (40 CFR 6, Appendix A)	Applicable	Directs federal agencies to avoid, where possible, adversely effecting or destroying wetlands. Requirements for wetlands determination, assessment, and preservation or restoration are set forth.	• To be considered in predesign studies.
	Floodplains	Federal Executive Order 11988 Floodplain Management (40 CFR 6, Appendix A)	Applicable	Requires federal agencies to avoid, where possible, adversely effecting floodplains. Requirements for floodplains determination, assessment, and preservation or restoration are set forth.	• To be considered in predesign studies.

TABLE 4-4
ARARs SPECIFIC TO REMEDIAL ALTERNATIVES 4 and 8A[1]
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Chemical-Specific	Air	Vermont Air Pollution Control Regulations (EPR Chapter 5)	Relevant and Appropriate	The following provisions of Vermont air emissions regulations address relevant and appropriate air pollution issues: controlling emissions of conventional pollutants and hazardous air pollutants to prevent ambient concentrations from exceeding NAAQS and Hazard Limiting Values, respectively; minimizing fugitive particulate emissions from material handling and construction; and controlling nuisances and odors.	• Gas collection system for the IWS Areas will be evaluated to determine if pollution thresholds are exceeded for control technology application.
		Federal NESHAP for Vinyl Chloride (40 CFR 61 Subpart F)	Relevant and Appropriate	Specifies that the concentration of vinyl chloride in exhaust gas from control equipment must not exceed 10 ppm.	• Gas collection system for the IWS Areas will be evaluated to determine if vinyl chloride thresholds are exceeded for control technology application.
		Federal NESHAP for Benzene Waste Operations (40 CFR 61 Subpart FF)	Relevant and Appropriate	Specifies that benzene waste treatment processes either: (1) removes benzene from the waste stream to a level less than 10 ppm, or (2) removes benzene from the waste stream by 99 percent or more on a mass basis, or (3) incinerates the benzene in a combustion unit that achieves a 99 percent destruction efficiency.	• Gas collection system for the IWS Areas will be evaluated to determine if benzene thresholds are exceeded for control technology application.

[1] Alternative 4: Containment (SWDA, IWS 1, 2, and 3)/In-Situ Soil Vapor Extraction of IWS2 /No Source Control Groundwater; Alternative 8A: Downgradient Groundwater Extraction/Treatment/Discharge/Combinedwith Alternative 2 or 4.

TABLE 4-4
ARARs SPECIFIC TO REMEDIAL ALTERNATIVES 4 and 8A[1]:
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Chemical-Specific (cont'd)	Groundwater	Vermont Hazardous Waste Regulations (EPR 7-502)	Relevant and Appropriate	This regulation establishes the maximum permissible concentrations of hazardous constituents in groundwater in the uppermost aquifer underlying the waste management area beyond the point of compliance. An alternate concentration limit (ACL), based on protection of human health and the environment, may be established by the Regional Administrator.	• Groundwater quality would improve due to presence of caps on SWDA and IWS Areas; however, maximum permissible concentrations for Contaminants of Concern that are currently exceeded will continue to be exceeded until or unless the source is depleted and/or natural degradation processes reduce their respective concentrations in groundwater below permissible levels.
		Vermont Groundwater Protection Regulations (EPR 12)	Applicable	Water quality standards apply to regulatory programs that may affect groundwater resources. Primary Ground Water Quality Standards cover a broad range of chemicals that, if present, may detract from the intended use of the ground water. These standards include an "remediation goal", based on federal MCLs, USEPA Office of Drinking Water, Lifetime Health Advisory, or a Vermont Health Advisory, and a "preventive action limit", which is either 10% or 50% of the remediation goal. Both trigger a specified response. Secondary Ground Water Quality Standards covering parameters that affect aesthetic qualities, also include a preventive action limit, which is 50% of the remediation goal.	• Groundwater quality would improve due to presence of caps on SWDA and IWS Areas; however, remediation goals for Contaminants of Concern that are currently exceeded will continue to be exceeded until or unless the source is depleted and/or natural degradation processes reduce their respective concentrations in groundwater below these standards.

TABLE 4-4
ARARs SPECIFIC TO REMEDIAL ALTERNATIVES 4 and 8A[1]:
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Chemical-Specific (cont'd)	Groundwater (cont'd)	Federal Safe Drinking Water Maximum Contaminant Levels (MCLs) for organic and inorganic chemicals (40 CFR 141 Subparts B, G, and I)	Relevant and Appropriate	MCLs have been promulgated for a number of common organic and inorganic contaminants; and action levels have been promulgated for lead and copper. These levels regulate the concentration of contaminants in public drinking water supplies, but may also be considered appropriate for groundwater aquifers potentially used for drinking water.	• Groundwater quality would improve due to presence of caps on SWDA and IWS Areas; however, MCLs for Contaminants of Concern that are currently exceeded will continue to be exceeded until or unless the source is depleted and/or natural degradation processes reduce their respective concentrations in groundwater below the MCLs.
		Federal Safe Drinking Water Maximum Contaminant Level Goals (MCLGs) for organic and inorganic chemicals (40 CFR 141 Subpart F)	Relevant and Appropriate	MCLGs are health-based goals (non-enforceable) for public water supplies. MCLGs are levels considered to have no known or anticipated negative health effects which includes a margin of safety. These goals are available for a number of organic and inorganic contaminants.	• Groundwater quality would improve due to presence of caps on SWDA and IWS Areas; however, MCLGs that are currently exceeded will continue to be exceeded until or unless the source is depleted and/or natural degradation processes reduce the concentrations of contaminants below the MCLGs.
		Federal Safe Drinking Water National Secondary Maximum Contaminant Levels (SMCLs) (40 CFR 143.3)	To Be Considered	These regulations control contaminants that affect the aesthetic qualities of drinking water such as appearance, odor, and taste. SMCLs are not federally enforceable but are intended to be used by states as guidelines.	• To be considered in selecting remedial alternative.
		Federal Safe Drinking Water proposed MCLs for synthetic organic chemicals and inorganic chemicals (40 CFR 141)	To Be Considered	These regulations would establish MCLs for certain chemical species.	• To be considered in selecting remedial alternative.
		Federal Drinking Water Health Advisories	To Be Considered	EPA publishes contaminant-specific health advisories that indicate the non-carcinogenic risks associated with consuming contaminated drinking water.	• To be considered in selecting remedial alternative.

TABLE 4-4
ARARs SPECIFIC TO REMEDIAL ALTERNATIVES 4 and 8A[1]:
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Chemical-Specific (cont'd)	Groundwater (cont'd)	Federal Groundwater Protection Strategy (EPA, August 1984)	To Be Considered	EPA's GPS includes a component which states that groundwater is ecologically vital, if the aquifer provides the base flow for a particularly sensitive ecosystem which, if polluted, would destroy a unique habitat.	• To be considered in selecting remedial alternative. • The aquifer below the Study Area does not provide the base flow for a sensitive habitat.
	Sediment	Federal Interim Sediment Quality Criteria	To Be Considered	Sediment quality criteria were compiled from studies of effects of toxic compounds in sediments on benthic biota. Sediment quality criteria have been published for metals, PAHs, and other persistent organic compounds.	• To be considered in selecting remedial alternative. • Sediment quality would improve due to presence of cap on SWDA and IWS Areas; however, sediment quality criteria for Contaminants of Concern that are currently exceeded will continue to be exceeded until or unless the source is depleted and/or natural degradation processes reduce their respective concentrations in sediment below the recommended criteria.
Action-Specific	N/A	Vermont Hazardous Waste Regulations (EPR Chapter 7 Subchapter 3)	Applicable	Hazardous waste that is generated from remedial activities and requires off-site disposal will need to be managed in accordance with generator requirements, including identification of waste, accumulation in containers or tanks, marking and labelling, and manifesting the waste to its final destination.	• Hazardous wastes generated during remedial activities will be managed in accordance with generator requirements.
		Vermont Hazardous Waste Regulations (EPR Chapter 7 Section 7-106)	Applicable	Hazardous waste that is manifested off-site will require notification to the TSDF that the waste is a restricted waste and either meets or does not meet LDR treatment standards.	• Hazardous wastes shipped off-site will be accompanied by LDR notification to the TSDF.

TABLE 4-4
ARARs SPECIFIC TO REMEDIAL ALTERNATIVES 4 and 8A[1]:
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Action-Specific (cont'd)	N/A	Vermont Hazardous Waste Regulations (EPR Chapter 7 Subchapter 5)	Applicable	These regulations establish requirements for hazardous waste facilities, including facility standards, emergency preparedness and prevention, and contingency planning. Closure of land disposal units shall be implemented to accomplish the objectives detailed in 40 CFR 264 Subpart F (Releases from waste management units), Subpart G (Closure and post-closure), and Subpart N (Landfills).	• Alternative 4 or 8A will satisfy security requirements and accomplish the specified objectives of closure and post-closure care that are applicable to IWS Areas.
		Vermont Solid Waste Regulations (EPR Section 6-702)	Applicable	Final cover on solid waste landfills are required to have a minimum slope of 5 percent and a maximum slope of 33⅓ percent. Grass or ground cover must be established within four months of final cover, or as soon as weather permits.	• Alternative 4 or 8A will satisfy the final cover requirements applicable to the SWDA.
		Federal Solid Waste Regulations (40 CFR 258.60)	To Be Considered	The final cover system installed on a solid waste landfill must be designed to minimize infiltration and erosion, and consist of an infiltration layer underlying an erosion layer. The infiltration layer must have at least 18" of earthen material that has a low permeability. The erosion layer must consist of at least 6" of earthen material that is capable of sustaining native plant growth.	• Vermont solid waste cover requirements are more stringent.
		EPA Technical Guidance Document: Final Covers on Hazardous Waste Landfills and Surface Impoundments	To Be Considered	Presents EPA recommendations on design specifications for multilayer landfill caps.	• To be considered in designing a cap for IWS Areas.
		Federal Noise Control Regulations (40 CFR 204, 205)	Applicable	Establish noise emission standards applicable to portable air compressors and medium and heavy duty trucks.	• Construction equipment will be required to comply with applicable noise emission standards.

TABLE 4-4
ARARs SPECIFIC TO REMEDIAL ALTERNATIVES 4 and 8A[1]:
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Action-Specific (cont'd)	N/A	Vermont Land Use and Development Law (Act 250 - 10 VSA Chapter 151)	Relevant and Appropriate	Construction of improvements on tracts of land larger than 10 acres are required to comply with criteria specified in the Act, including no undue air or water pollution, no disposal of harmful or toxic substances to groundwater, no unreasonable soil erosion, compliance with wetlands rules, and no adverse affects on aesthetic values.	• Alternative 4 or 8A facilitates compliance with the Act by reducing leachate generation and controlling erosion from SWDA and IWS Areas.
	Air	Federal Proposed Regulation for Control of VOCs	To Be Considered	Proposes emission standards for VOCs from groundwater treatment units such as air strippers.	• To be considered in predesign studies.
	Surface Waters	Vermont Water Quality Standards (EPR Section 2-05))	Applicable	Stormwater runoff shall not have an undue adverse effect on the receiving waters.	• Alternative 4 or 8A will facilitate compliance with this requirement by controlling erosion and runoff from SWDA and IWS Areas.
Location-Specific	Floodplains and Seismic Zones	Vermont Hazardous Waste Regulations (EPR 7-502)	Relevant and Appropriate	Hazardous waste disposal facilities are not to be located in seismically active areas nor in 100-year floodplains (unless washout can be prevented or no adverse effects of washout can be substantiated).	• IWS Areas are not located in a seismically active area or in a 100-year floodplain.
	Groundwater, Wetlands, and Floodplains	Vermont Solid Waste Regulations (EPR 6-502, 503)	Relevant and Appropriate	Solid waste disposal facilities are not to be located in Class I or Class II groundwater areas, significant wetlands, or a 100-year floodplain/flood stage elevation. Solid waste facilities are to be located so as not to adversely affect drinking water supplies.	• The SWDA is not located in the sensitive areas outlined.
	Wetlands	Vermont Wetland Rules	Applicable	These regulations include procedures for the identification, classification, and protection of wetlands.	• Alternative 4 or 8A improves protection of significant wetlands.

TABLE 4-4
ARARs SPECIFIC TO REMEDIAL ALTERNATIVES 4 and 8A[1]:
Parker Landfill Feasibility Study
Lyndonville, Vermont

Type	Medium	Requirements	Status	Synopsis of Requirement	Action to be taken to attain ARAR
Location-Specific (cont'd)	Wetlands (cont'd)	Federal Guidelines for Specification of Disposal Sites for Dredged or Fill Material (40 CFR 230)	Relevant and Appropriate	A proposed disposal site for the discharge of dredged or fill material is determined to be either in compliance or non-compliance with the guidelines given here. These guidelines cover potential impacts on human use characteristics and potential impacts on aquatic ecosystems including: physical and chemical characteristics, biological characteristics, and special aquatic sites. The regulations also specify evaluation and testing to make determinations, and actions to minimize adverse effects.	• Alternative 4 or 8A minimizes adverse effects to wetlands in the Study Area.
		Federal Fish and Wildlife Coordination Regulations (50 CFR 297)	Applicable	Establishes requirements for a consultation with U.S. Fish and Wildlife Service and state wildlife agencies to mitigate losses of fish and wildlife that result from modification of waters.	• Alternative 4 or 8A meets this requirement.
		Federal Army Corps of Engineers Nationwide Permit Program Regulations (33 CFR 330, Appendix A)	Relevant and Appropriate	Lists conditions that must be met for the nationwide general permit to discharge dredged or fill material. These conditions include consideration of maintenance, erosion and siltation controls, aquatic life movements, equipment usage, endangered species, suitable material, and mitigation.	• Substantive conditions for a general permit will be met under this alternative.
		Federal Executive Order 11990 Protection of Wetlands (40 CFR 6, Appendix A)	Applicable	Directs federal agencies to avoid, where possible, adversely effecting or destroying wetlands. Requirements for wetlands determination, assessment, and preservation or restoration are set forth.	• To be considered in predesign studies.

TABLE 4-5
CHEMICAL-SPECIFIC ARARs: CRITERIA, ADVISORIES, AND GUIDANCE
Parker Landfill Feasibility Study
Lyndonville, Vermont

Medium	Requirements	Status	Alternatives	Synopsis of Requirement	Action to be taken to attain ARAR
STATE REGULATORY REQUIREMENT					
Air	Vermont Air Pollution Control Regulations (EPR Chapter 5)	Relevant and Appropriate	2; 3; 4; 5; 8a; 8b	Address controlling emissions of conventional pollutants and hazardous air pollutants to prevent ambient concentrations from exceeding NAAQS and Hazard Limiting Values, respectively; minimizing fugitive particulate emissions from material handling and construction; and controlling nuisances and odors.	• Gas collection system for the IWS Areas will be evaluated to determine if pollution thresholds are exceeded for control technology application.
Groundwater	Vermont Hazardous Waste Regulations (EPR 7-502)	Relevant and Appropriate	1; 2; 3; 4; 5; 8a; 8b	Establishes the maximum permissible concentrations of hazardous constituents in groundwater in the uppermost aquifer underlying the waste management area beyond the point of compliance.	• Maximum permissible concentrations were considered in developing cleanup levels.
	Vermont Groundwater Protection Regulations (EPR 12)	Applicable	1; 2; 3; 4; 5; 8a; 8b	Primary Ground Water Quality Standards cover a broad range of chemicals that may detract from the intended use of the ground water. Secondary Ground Water Quality Standards cover parameters that affect aesthetic qualities.	• Water quality standards were considered in developing cleanup standards.
FEDERAL REGULATORY REQUIREMENTS					
Air	Federal NESHAP for Vinyl Chloride (40 CFR 61 Subpart F)	Relevant and Appropriate	2; 3; 4; 5; 8a; 8b	Specifies that the concentration of vinyl chloride in exhaust gas from control equipment must not exceed 10 ppm.	• Vinyl chloride threshold was considered for control technology application.

TABLE 4-5
CHEMICAL-SPECIFIC ARARs: CRITERIA, ADVISORIES, AND GUIDANCE
Parker Landfill Feasibility Study
Lyndonville, Vermont

Medium	Requirements	Status	Alternatives	Synopsis of Requirement	Action to be taken to attain ARAR
Air (cont'd)	Federal NESHAP for Benzene Waste Operations (40 CFR 61 Subpart FF)	Relevant and Appropriate	2; 3; 4; 5; 8a; 8b	Specifies that benzene waste treatment processes either: (1) removes benzene from the waste stream to a level less than 10 ppm, or (2) removes benzene from the waste stream by 99 percent or more on a mass basis, or (3) incinerates the benzene in a combustion unit that achieves a 99 percent destruction efficiency.	• Benzene threshold was considered for control technology application.
Groundwater	Federal Safe Drinking Water Maximum Contaminant Levels (MCLs) for organic and inorganic chemicals (40 CFR 141 Subparts B, G, and I)	Relevant and Appropriate	1; 2; 3; 4; 5; 8a; 8b	MCLs have been promulgated for a number of common organic and inorganic contaminants; and action levels have been promulgated for lead and copper. These levels regulate the concentration of contaminants in public drinking water supplies, but may also be considered appropriate for groundwater aquifers potentially used for drinking water.	• The concentrations of constituents were compared to MCLs. MCLs were considered in developing recommended cleanup levels for groundwater.
	Federal Safe Drinking Water Maximum Contaminant Level Goals (MCLGs) for organic and inorganic chemicals (40 CFR 141 Subpart F)	Relevant and Appropriate	1; 2; 3; 4; 5; 8a; 8b	MCLGs are health-based goals (non-enforceable) for public water supplies. MCLGs are levels considered to have no known or anticipated negative health effects which includes a margin of safety. These goals are available for a number of organic and inorganic contaminants.	• MCLGs were considered in developing recommended cleanup levels for groundwater.
	Federal Safe Drinking Water National Secondary Maximum Contaminant Levels (SMCLs) (40 CFR 143.3)	To Be Considered	1; 2; 3; 4; 5; 8a; 8b	These regulations control contaminants that affect the aesthetic qualities of drinking water such as appearance, odor, and taste. SMCLs are not federally enforceable but are intended to be used by states as guidelines.	• SMCLs were considered in developing cleanup levels.
	Federal Safe Drinking Water proposed MCLs for synthetic organic chemicals and inorganic chemicals (40 CFR 141)	To Be Considered	1; 2; 3; 4; 5; 8a; 8b	These regulations would establish MCLs for certain chemical species.	• Proposed MCLs were considered in developing cleanup levels.

TABLE 4-5
CHEMICAL-SPECIFIC ARARs: CRITERIA, ADVISORIES, AND GUIDANCE
Parker Landfill Feasibility Study
Lyndonville, Vermont

Medium	Requirements	Status	Alternatives	Synopsis of Requirement	Action to be taken to attain ARAR
Groundwater (cont'd)	Federal Drinking Water Health Advisories	To Be Considered	1; 2; 3; 4; 5; 8a; 8b	EPA publishes contaminant-specific health advisories that indicate the non-carcinogenic risks associated with consuming contaminated drinking water.	• Health advisories were considered in developing cleanup levels.
	Federal Groundwater Protection Strategy (EPA, August 1984)	To Be Considered	1; 2; 3; 4; 5; 8a; 8b	EPA's GPS includes a component which states that groundwater is ecologically vital, if the aquifer provides the base flow for a particularly sensitive ecosystem which, if polluted, would destroy a unique habitat.	• EPA's groundwater protection strategy was considered during development of remedial alternatives. • The aquifer below the Study Area does not provide the base flow for a sensitive habitat.
Sediment	Federal Interim Sediment Quality Criteria	To Be Considered	1; 2; 3; 4; 5; 8a; 8b	Sediment quality criteria were compiled from studies of effects of toxic compounds in sediments on benthic biota. Sediment quality criteria have been published for metals, PAHs, and other persistent organic compounds.	• Sediment quality criteria were considered in development of cleanup levels.

TABLE 4-6
ACTION-SPECIFIC ARARs: CRITERIA, ADVISORIES, AND GUIDANCE
Parker Landfill Feasibility Study
Lyndonville, Vermont

Medium	Requirements	Status	Alternatives	Synopsis of Requirement	Action to be taken to attain ARAR
STATE REGULATORY REQUIREMENT					
N/A	Vermont Hazardous Waste Regulations (EPR Chapter 7 Subchapter 3)	Applicable	3; 4; 5; 8A; 8B	Hazardous waste that is generated from remedial activities and requires off-site disposal will need to be managed in accordance with generator requirements, including identification of waste, accumulation in containers or tanks, marking and labelling, and manifesting the waste to its final destination.	• Spent carbon generated during remedial activities will be managed in accordance with generator requirements.
	Vermont Hazardous Waste Regulations (EPR Chapter 7 Section 7-106)	Applicable	3; 4; 5; 8A; 8B	Hazardous waste that is manifested off-site will require notification to the TSDF that the waste is a restricted waste and either meets or does not meet LDR treatment standards.	• Hazardous wastes shipped off-site will be accompanied by LDR notification to the TSDF.
	Vermont Hazardous Waste Regulations (EPR Chapter 7 Subchapter 5)	Applicable	2; 3; 4; 5; 8A; 8B	These regulations establish requirements for hazardous waste facilities, including facility standards, emergency preparedness and prevention, and contingency planning. Closure of land disposal units shall be implemented to accomplish the objectives detailed in 40 CFR 264 Subpart F (Releases from waste management units), Subpart G (Closure and post-closure), and Subpart N (Landfills).	• Security requirements and specified objectives of closure and post-closure care that are applicable to IWS Areas, were considered in developing remedial alternatives.
	Vermont Solid Waste Regulations (EPR Section 6-702)	Applicable	1; 2; 3; 4; 5; 8A; 8B	Final cover on solid waste landfills are required to have a minimum slope of 5 percent and a maximum slope of 33⅓ percent. Grass or ground cover must be established within four months of final cover, or as soon as weather permits.	• Final cover requirements applicable to the SWDA were considered in developing remedial alternatives.

TABLE 4-6
ACTION-SPECIFIC ARARs: CRITERIA, ADVISORIES, AND GUIDANCE
Parker Landfill Feasibility Study
Lyndonville, Vermont

Medium	Requirements	Status	Alternatives	Synopsis of Requirement	Action to be taken to attain ARAR
N/A	Vermont Land Use and Development Law (Act 250 - 10 VSA Chapter 151)	Relevant and Appropriate	1; 2; 3; 4; 5; 8A; 8B	Construction of improvements on tracts of land larger than 10 acres are required to comply with criteria specified in the Act, including no undue air or water pollution, no disposal of harmful or toxic substances to groundwater, no unreasonable soil erosion, compliance with wetlands rules, and no adverse affects on aesthetic values.	• Act 250 requirements were considered in developing remedial alternatives.
Surface Waters	Vermont Water Quality Standards (EPR Section 1-04)	Applicable	3; 5; 8B	Outlines criteria for discharging into waters of the state and discusses the assimilative capacity of such waters.	• These criteria will be considered in predesign.
	Vermont Water Quality Standards (EPR Section 2-02)	Applicable	3; 5; 8B	Water quality criteria are to be calculated on the basis of 7Q10 flow values.	• The requirement will be considered in predesign.
	Vermont Water Quality Standards (EPR Section 2-03)	Applicable	3; 5; 8B	A specific portion of the receiving waters that does not exceed 200 feet from the point of discharge shall be the designated mixing zone for properly treated waste. The mixing zone shall not have adverse effects on human health, aquatic life, or existing uses of the receiving waters.	• These requirements will be considered in predesign.
	Vermont Water Quality Standards (EPR Section 2-05))	Applicable	1; 2; 3; 4; 5; 8A; 8B	Stormwater runoff shall not have an undue adverse effect on the receiving waters.	• Stormwater runoff was considered in developing remedial alternatives.
	Vermont Water Quality Standards (EPR Section 3-01)	Applicable	3; 5; 8B	Outlines the established criteria for dissolved oxygen, temperature, phosphorus, nitrates, aquatic habitats, sludge deposits or solid refuse, solids and oil, alkalinity, pH, and toxic substances, except in mixing zones.	• These criteria will be considered in predesign.
	Vermont Water Quality Standards (EPR Section 3-04)	Applicable	3; 5; 8B	Outlines the criteria for turbidity, *E. coli*, color, taste, and odor, except in mixing zones.	• These criteria will be considered in predesign.

TABLE 4-6
ACTION-SPECIFIC ARARs: CRITERIA, ADVISORIES, AND GUIDANCE
Parker Landfill Feasibility Study
Lyndonville, Vermont

Medium	Requirements	Status	Alternatives	Synopsis of Requirement	Action to be taken to attain ARAR
Surface Waters (cont'd)	Vermont Water Quality Standards (EPR Section 3-06)	Applicable	3; 5; 8B	Toxic wastes concentrations shall not have an adverse impact on human health, or aquatic life.	• This requirement will be considered in predesign.
	Vermont Water Quality Standards (EPR Appendix D)	Applicable	3; 5; 8B	Outlines current water quality criteria for the protection of aquatic biota.	• These criteria will be considered in predesign.
	Vermont NPDES Permit Program Regulations (EPR Chapter 13)	Relevant and Appropriate	3; 5; 8B	Specify the procedures required to obtain a NPDES permit to discharge any waste into the waters of Vermont, and the terms and conditions of permits. Requirements for monitoring, recording, and reporting are also included.	• A NPDES permit will be obtained for discharges to the Passumpsic River.
FEDERAL REGULATORY REQUIREMENTS					
N/A	Federal Solid Waste Regulations (40 CFR 258.60)	To Be Considered	1; 2; 3; 4; 5; 8A; 8B	The final cover system installed on a solid waste landfill must be designed to minimize infiltration and erosion, and consist of an infiltration layer underlying an erosion layer. The infiltration layer must have at least 18" of earthen material that has a low permeability. The erosion layer must consist of at least 6" of earthen material that is capable of sustaining native plant growth.	• Vermont solid waste cover requirements are more stringent.
	EPA Technical Guidance Document: Final Covers on Hazardous Waste Landfills and Surface Impoundments	To Be Considered	2; 3; 4; 5; 8A; 8B	Presents EPA recommendations on design specifications for multilayer landfill caps.	• To be considered in designing a cap for IWS Areas.
	Federal Noise Control Regulations (40 CFR 204, 205)	Applicable	2; 3; 4; 5; 8A; 8B	Establish noise emission standards applicable to portable air compressors and medium and heavy duty trucks.	• Construction equipment will comply with applicable noise emission standards.

TABLE 4-6
ACTION-SPECIFIC ARARs: CRITERIA, ADVISORIES, AND GUIDANCE
Parker Landfill Feasibility Study
Lyndonville, Vermont

Medium	Requirements	Status	Alternatives	Synopsis of Requirement	Action to be taken to attain ARAR
Air	Federal Proposed Regulation for Control of VOCs	To Be Considered	2; 3; 4; 5; 8A; 8B	Proposes emission standards for VOCs from groundwater treatment units such as air strippers.	• To be considered in predesign studies.
Surface Waters	Federal Quality Criteria for Water	Applicable	3; 5; 8B	Pursuant to Section 304(a)(1) of the Clean Water Act, the EPA establishes ambient water quality criteria. These criteria present scientific data and guidance on the environmental effects of pollutants. The criteria can contribute to establishing regulatory requirements that govern impacts to water quality.	• These criteria will be considered in predesign.

TABLE 4-7
LOCATION-SPECIFIC ARARs: CRITERIA, ADVISORIES, AND GUIDANCE
Parker Landfill Feasibility Study
Lyndonville, Vermont

Medium	Requirements	Status	Alternatives	Synopsis of Requirement	Action to be taken to attain ARAR
STATE REGULATORY REQUIREMENTS					
Floodplains and Seismic Zones	Vermont Hazardous Waste Regulations (EPR 7-502)	Relevant and Appropriate	1; 2; 3; 4; 5; 8a; 8b	Hazardous waste disposal facilities are not to be located in seismically active areas nor in 100-year floodplains (unless washout can be prevented or no adverse effects of washout can be substantiated).	• IWS Areas are not located in a seismically active area or in a 100-year floodplain.
Groundwater, Wetlands, and Floodplains	Vermont Solid Waste Regulations (EPR 6-502, 503)	Relevant and Appropriate	1; 2; 3; 4; 5; 8a; 8b	Solid waste disposal facilities are not to be located in Class I or Class II groundwater areas, significant wetlands, or a 100-year floodplain/flood stage elevation. Solid waste facilities are to be located so as not to adversely affect drinking water supplies.	• The SWDA is not located in the sensitive areas outlined.
Wetlands	Vermont Wetland Rules	Applicable	2; 3; 4; 5; 8a; 8b	These regulations include procedures for the identification, classification, and protection of wetlands.	• Protection of significant wetlands was considered in development of remedial alternatives.
FEDERAL REGULATORY REQUIREMENTS					
Wetlands	Federal Guidelines for Specification of Disposal Sites for Dredged or Fill Material (40 CFR 230)	Relevant and Appropriate	2; 3; 4; 5; 8a; 8b	These guidelines cover potential impacts of depositing fill material in wetlands on human use characteristics and on aquatic ecosystems including: physical and chemical characteristics, biological characteristics, and special aquatic sites. The regulations also specify evaluation and testing to make determinations, and actions to minimize adverse effects.	• Wetland impacts and mitigation alternatives will be assessed during predesign studies.
	Federal Fish and Wildlife Coordination Regulations (50 CFR 297)	Applicable	2; 3; 4; 5; 8a; 8b	Establishes requirements for a consultation with U.S. Fish and Wildlife Service and state wildlife agencies to mitigate losses of fish and wildlife that result from modification of waters.	• Agencies will be consulted to assist in minimizing and/or mitigating impacts.

TABLE 4-7
LOCATION-SPECIFIC ARARs: CRITERIA, ADVISORIES, AND GUIDANCE
Parker Landfill Feasibility Study
Lyndonville, Vermont

Medium	Requirements	Status	Alternatives	Synopsis of Requirement	Action to be taken to attain ARAR
Wetlands (cont'd)	Federal Army Corps of Engineers Nationwide Permit Program Regulations (33 CFR 330, Appendix A)	Relevant and Appropriate	2; 3; 4; 5; 8a; 8b	Lists conditions that must be met for the nationwide general permit to discharge dredged or fill material. These conditions include consideration of maintenance, erosion and siltation controls, aquatic life movements, equipment usage, endangered species, and mitigation.	• Nationwide permit conditions will be considered in predesign studies.
	Federal Executive Order 11990 Protection of Wetlands (40 CFR 6, Appendix A)	Applicable	2; 3; 4; 5; 8a; 8b	Directs federal agencies to avoid, where possible, adversely effecting or destroying wetlands. Requirements for wetlands determination, assessment, and preservation or restoration are set forth.	• Wetland impacts will be minimized and/or mitigated.
Floodplains	Federal Executive Order 11988 Floodplain Management (40 CFR 6, Appendix A)	Applicable	3; 5; 8b	Requires federal agencies to avoid, where possible, adversely effecting floodplains. Requirements for floodplains determination, assessment, and preservation or restoration are set forth.	To be considered in predesign studies.

Table 4-8

Concentrations of Contaminants of Concern for Treatment System Design Parker Landfill Project Lyndonville, Vermont

Contaminant of Concern	Alternative 3,5 (mg/l)	Alternative 6A (mg/l)	Alternative 6B (mg/l)
Acetone	0.001	0.0005	0.0008
Benzene	0.0003	0.0002	0.0003
2-Butanone	0.0016	0.0008	0.0013
Carbon Disulfide	0.0002	0.0002	0.0003
Chloroethane	0.0002	0.0001	0.0002
Chloromethane	0	0.0000	0.0000
1,1-Dichloroethane	0.0029	0.0013	0.0023
1,2-Dichloroethene	0.0331	0.0155	0.0263
1,2-Dichloropropane	0.0003	0.0001	0.0002
Ethylbenzene	0.0059	0.0030	0.0056
2-Hexanone	0.0098	0.0053	0.0093
MethyleneChloride	0.0001	0.0000	0.0000
4-Methyl-2-Pentanone	0.0123	0.0060	0.0102
Tetrachlorethene	0.0183	0.0087	0.0152
Toluene	0.0636	0.0340	0.0568
1,1,1-Trichloroethane	0.0118	0.0066	0.0111
Trichloroethene	0.5268	0.2634	0.4439
Vinyl Chloride	0	0.0000	0.0000
Xylenes	0.0151	0.0087	0.0143
Benzoic Acid	0.2919	0.1479	0.2536
bis(2)-Ethylhexyl Phthalate	0.0174	0.0147	0.0178
1,4-Dichlorobenzene	0	0.0001	0.0000
Diethyl Phthalate	0.0082	0.0038	0.0065
de-n-butyl Phthalate	0.0126	0.0055	0.0104
2-Methyl naphthale	0	0.0001	0.0000
2-Methyl phenol	0.001	0.0005	0.0009
4-Methyl phenol	0.402	0.1301	0.2227
Naphthalene	0.0008	0.0008	0.0008
n-Nitrosodipheamine	0.001	0.0002	0.0006
Phenol	0.0007	0.0004	0.0006
Total organics	1.4389	0.6583	1.1120

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